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COURSE OF INSTRUCTION

UNITED STATES MARITIME SERVICE
TANKER MATES HANDBOOK

THIS BOOK COMPILED AND EDITED
BY
LT.(jg.) D.J. LEDOUX U.S.M.S.
INSTRUCTOR
U.S. MARITIME SERVICE
TANKER MATES SCHOOL

APPRECIATION
TO
THE MARINSHIP CORPORATION
W. E. WASTE, GENERAL MGR.

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INTRODUCTION

This book has been compiled for use as a text book in the training program of the U. S. Maritime Service Tanker Mates School located at Marin Shipyard.

No attempt will be made to describe any type of tanker except the new T2-SE-A2 being built at Marin Shipyard, with occasional reference to the T2-SE-A1 tank ships being built at Swan Island. Except as to horsepower and details both the A-1's and A-2's are identical from the tanker mates viewpoint. To deck officers unfamiliar with tanker ships and to prospective tanker men, this book gives the necessary step by step procedure in the loading and discharging of inflammable and combustible cargoes. Tanker mates unfamiliar with tankers should obtain and study the pamphlet entitled "A Manual for the safe handling of Inflammable and Combustible Liquids" and the book "Tank Vessels". These are government publications and can be obtained from the Steamboat Inspectors.

The new T2-SE-A2 and A-1 tankers are not being built just for war service, but have been designed and built to become a permanent part of our merchant marine. They are built of good material, are well constructed, and will give good service for years to come. As they are of the most modern design, the older type of tankers will rapidly become obsolete and the T2-SE-A1 and A-2's will comprise the bulk of our tanker fleets.

To seafaring men who are interested in steady employment both during and after the war, they will do well to choose tanker vessel service as a career. Tanker vessels have for years paid higher wages, have better quarters, and better subsistence than any ships under the American flag. Oil companies are known as good employers. Due to the higher rate of pay and better living conditions on board tankers, a much better type of seaman is attracted and labor turnover is very low in comparison with other types of ships. It is not unusual to find sailors and engine room men on tankers who have been attached to the same vessel or vessels of the same company for six and eight years. A large percentage of licensed officers stay until retirement.

Another factor in choosing tanker vessel service as a career is the fact that as our petroleum resources become depleted, our tanker fleets will become larger and roam further to bring this life blood of war and commerce to our shores. It is of course true that the more tankers there are and the more business they do, the better will be the chances of steady employment for the tanker man.

Although this book has been compiled primarily for Deck Officers unfamiliar with tanker ship procedure, experienced Tanker men will find the tables and isometric drawings of great use.

DESCRIPTION OF THE T2-SE-A2 TANKERS

The T2-SE-A2 are 523' 6" over all, are 503' between perpendiculars at moulded draft. They have a moulded beam of 68'. The draft, moulded to the summer "Freeboard Mark" is 29' 11½".

The displacement tonnage, in sea water at 35 cu. ft. per ton of 2240 lbs. is 21,670 tons. Deadweight capacity, 16,460 tons. Capacity of cargo oil tanks at 100% full, about 140,600 bbls. of 42 gallons each. Fuel tanks 100% full have a capacity of 4,920 bbls.

The T2-SE-A2 tankers are Turbo-Electric drive, single screw, of 10,000 S.H.P. The vessels are the three island, bulk oil tanker type. There is one complete upper deck, carrying the forecastle, bridge and bridge houses, poop and poop houses, and with a walkway at the bridge deck level extending to the poop and forecastle from each end of the bridge.

There are several new improvements on these vessels over the older type tankers. Loading drops leading directly from deck loading lines to cargo tanks, permit loading of entire cargo without routing thru the pumproom. Drop lines are also provided with a hose connection for washing out the drop and loading line.

On these tankers the vent system is in 3 units. The first unit is a combination pressure and vacuum valve. Free access to the atmosphere is obtained at 2 lbs. pressure and the vacuum side of valve operates when 1 lb. vacuum is reached. The first unit is installed alongside the walk way and with exception of #1 tank, each valve takes care of three tanks, the unit for #1 tank is a single valve.

The second unit in the vent system is the pressure relief valve, set to operate at 2½ lbs. pressure. This valve is installed on the vent pipes leading up the masts. It will operate in case the flame arrestor is plugged up.

The third unit is installed at the crosstrees of the masts and is known as the "Flame Arrestor". Its purpose is as the name implies, for arresting flame.

Under the forecastle head, all lockers, boatswains store rooms, and chain lockers, are pumped out with what is known as "Steam Ejectors".

Flame screens for ullage holes do not have to be removed when ullage hole cover is closed, but can be left in holes at all times.

Tank tops can be raised by one man by means of a ratchet wrench.

A docking telegraph is provided between the bridge and stern. An emergency steering wheel, telegraph and telephone is installed just forward of the stack on the engine room skylight trunk.

A Gyro compass and Iron Mike is installed, with the Master Gyro on the bridge.

To load bunker fuel, in fore deep tanks and aft bunker tanks, three connections are available. One alongside the forward pumproom, one at the mid-ship risers, and one at the bunker tanks aft. A fuel oil transfer line runs from the forward pumproom, clear aft to the bunker loading drops, on the main deck.

TANKER NOMENCLATURE

TERM	MEANING
1. Ullage or Outage--	The space between the under side of the deck to top of oil in tank, or space in tank not occupied by oil.
2. Innage--	The amount of oil in the tank measured from bottom of tank to top of oil.
3. Ullage Hole--	This is the small hole cut thru the large tank top cover.
4. Ullage's--	These are the gauges taken with a steel tape from the lip of the ullage hole, usually read as feet, inches and fractions of inches.
5. Ullage Tables--	Are calibrated tables, one for each tank, giving the amount of oil in barrels, for ullages from the bottom of tank to under side of deck.
6. Barrels of Oil in Bulk--	A barrel of oil in bulk contains 42 U.S. Gal.
7. Standard Temperature--	Oil is figured at the standard Temperature of 60° F.
8. Ullage Hole Flame Screens--	Are fine mesh copper screens that fit into ullage holes.
9. Scupper Plugs--	May be of wood or metal, are used to plug deck scuppers to prevent oil running over board in case of a spilling of oil or other liquid cargo.
10. A Spill--	The act of filling a tank full and running it over on deck. May also come from a hose, when it is being disconnected.
11. Sawdust--	Ordinary sawdust used to clean up a spill. Tankers carry a good supply of sawdust in sacks.
12. Bonding Cable--	A heavily insulated copper cable that makes contact between the hull of the ship and the shore pipe line, It is used to conduct static electricity harmlessly to a ground.
13. Risor--	Is a pipe where a hose is connected on the ship or on the dock.
14. Flange--	A circular piece of metal attached to a risor and to a hose. Flanges are bolted together to join a hose to a risor.
15. Bleeder Valve--	Is a small piece of pipe tapped into a risor in a vertical position directly back of the flange for the purpose of admitting air into hose or line or to take samples from the line. It is sometimes fitted with an air hose connection to blow hose clean of oil before disconnecting.

		MEANING
16.	Reducer--	This is a short section of pipe having one end smaller than the other. It is fitted with a flange on both ends and is for connecting a larger or smaller hose to a pipe of a constant diameter.
17.	Elbows--	Are curved pieces of pipe of different diameters and different arc's of curvature, with flange on each end. Used to have hose lead in different directions.
18.	Spool--	Short or long sections of pipe of different diameters same diameters on both ends. Flanges on both ends. Used to extend length or risor.
19.	Non-sparking Tools--	Tool used to connect or disconnect hoses is made of non-sparking material.
20.	Spud or Spike Wrench--	This is a wrench whose handle is spike form it is useful in lining up bolt holes in flanges.
21.	Thieving or Thieved--	The Act of finding the amount of water on the bottom of a tank containing oil.
22.	J.W. Gas Indicator--	An instrument for determining the amount of gas vapor present in an empty tank or enclosed space.
23.	Butterworth Equipment--	Apparatus used in tank cleaning, consists of a whirling spray nozzle.
24.	Steam Smothering Lines--	Lines running from a main steam line to every cargo tank and to various enclosed spaces. Primary purpose, fire fighting. Secondary purpose steaming tanks for cleaning.
25.	Steam heating Coils--	Steam coils running fore and aft at bottom of cargo tanks for purpose of heating oil in tank.
26.	Fire Foam Apparatus--	Consists of a hopper connected to a double hose connection. Dry foam powder is poured into hopper and falls into water stream. This is shot from hose as foam and smothers fire.
27.	Fresh Air Gas Mask--	This is a rubber mask with a breather hose attached. It is usually stored in a trunk that contains an air blower, operated by hand. Fresh air is pumped thru hose to mask. It is used when entering tanks or closed spaces contaminated by gas vapor.
28.	CO_2Fire Extinguishing System--	On Tankers carbon dioxide (CO_2) gas is usually piped direct to spaces to be protected. Gas is contained in steel cylinders and so arranged that a certain number of cylinders can be discharged into any compartment or tank.

TERM MEANING

29. Main Suction Valves--These are the valves controlling the suction from each cargo tank. The main part of the tank cargo is discharged thru these valves.

30. Stripping Suction Valves--After the main part of a tank of oil is discharged it is stripped dry with the stripping line which is controlled by the striping valve.

31. Main Suction Foot--An oblong casting that sets on the bottom of the tank at the lowest point. The clearance at the bottom is about 2" or 3".

32. Stripper Suction Foot--A round casting that sets in a similiar position to the main suction foot.

33. Stripping-- The act of draining a tank dry.

34. Cross-overers-- Main cargo lines and stripper lines running athwartships from tank to tank, also sections of pipe connecting main lines.

35. Master or Block Valves--Valves on a main line used to block off a tank from an ajoining tank, also to block off tanks from pumps.

36. Main Loading and discharge lines--Lines running fore and aft connecting into pumps, cross-overs connect into these lines.

37. Main Cargo Pumps-- Used to discharge main part of cargo.

38. Stripping Pumps-- Used to strip tanks dry.

39. Strainer Boxes-- These may be square or round in shape. A strainer is placed in box in a position, designed to catch foreign matter from cargo tanks before it can enter pumps. It is placed so that oil must come thru the box before it can enter pump.

40. Water Ballast-- When a tanker is empty, either fresh water or salt water may be taken into main cargo tanks or forepeak tank, as ballast. This may be either pumped in or out, or gravitated in or out.

41. Gravitating-- Oil cargo may be gravitated from tank to tank, or water may be gravitated into or out of a cargo tank, thru sea suctions. There must be a head of fluid and this will flow to a lower head by gravity.

42. Pressure Relief Valves--These are spring loaded valves, usually used on reciprocating pumps. It's purpose is to provide relief from excessive pressure. It is placed on discharge side of pump. In case of too much back pressure on pump, seat of valve lifts, allowing fluid to escape into intake side of pump.

	TERM	MEANING
43.	Surge Chamber--	This is always found on a reciprocating pump. Its purpose is to provide a cushion of air on fluid side of pump, thereby preventing pump hammer or pounding.
44.	Stop Check Stripping Valve--	This is a seat valve, so constructed as to become a gravity check valve when open turn and a half to two turns. Valve is free to move up and down on stem about one inch.
45.	Deck Sprinklers--	Are used in hot weather to throw a spray of water over decks to keep decks cool, thus lowering temperature in cargo tanks. They are connected to fire line.
46.	Spectacle--	These are pieces of metal cut in the shape of a pair of spectacles. A hole of the inside diameter of the pipe where it is to be used is cut in one end. The other end is left blank. Holes are cut for bolts on both ends. Either the blank end or open end is inserted between flanges of a pipe line depending upon whether line is to blanked off or left open.
47.	Vent System--	Vapor from products in tanks is conveyed from tank hatch coaming thru suitable piping which is lead up mast, allowing vapor to escape to atmosphere.
48.	Vent, Pressure and Vacumn Valve--	This is first unit vapor passes thru on its way to atmosphere. The valve consists of a heavy cylinder that seats. When vapor pressure exceeds 2 lbs. pressure, cylinder is forced from seat, allowing vapor to escape into vent line up mast. Vacumn side of valve is a flat disc on a seat. When vacumn in tank exceeds 1 lb. pressure, disc is raised from seat allowing air to enter tank. The pressure cylinder is equipped with a wheel which allows heavy cylinder to be raised mechanically, thus allowing vapor free access to vent up mast.
49.	Vent, Emergency Pressure and Relief Valve--	This valve is identical with the above except it has no mechanical control, or vacumn disc part. It automatically operates, in case flame arrestor becomes plugged up. Valve set for#2½ pressure.
50.	Flame Arrestor--	This is placed in vent system at top of mast. It is constructed of a number of corrugated plates pressed together. It allows vapor to pass thru, but as the name implies, it will not allow flame to pass in from outside.

LOADING A TANKER

As soon as the ship is fast alongside the dock, the fire wire is hung over the bow and stern on the offshore side. Gangway is put ashore and portable sign stating, "NO SMOKING, NO NAKED LIGHTS, NO VISITORS", is hung at the gangway. The Bonding Cable is connected, Scupper Plugs are inserted, Ullage hole covers are opened and inspected to be certain that flame screens are in place.

When loading cargo and ship has steam up sufficient to run fire pumps (this would be when a combustible cargo was being loaded), enough fire hoses to reach any part of cargo tanks are connected to ships fire line and stretched out on deck ready for use. Also fire foam apparatus is on deck connected up with a good supply of fire foam powder in cans close at hand.

When an inflammable cargo is to be loaded, the ships boiler fires are extinguished and of course the ships fire pumps cannot be operated. In this case a fire hose is lead from ships fire line to a water connection on the dock and fire water and pressure is obtained from the dock fire line.

Also when the ship is shut down, electricity for lights is obtained by running a heavily insulated cable as far aft of the ship as possible and connecting it to shore supply. The engineers are in charge of hooking up this cable.

Tanks are inspected by Officer on watch, possibly accompanied by the dock man, in order to determine that tanks are in right condition to receive cargo.

When ready to receive cargo, "notice of Readiness" is served on the Dockman and signed by him and Officer on duty. This is a company form and is usually made out in triplicate. The time of serving is noted on the form and detention incured after serving is entered in the Logbook as dock detention, one copy is given to the dockman at the time of signing, one copy sent to company office and one copy retained on board the ship.

All valves on deck and in pumproom will have been lined up in accordance with loading orders. These loading orders will have come on board from the tow boat or as soon as the ship is alongside the dock. It is a good practice to have more than one man check setting of valves on deck and in the pumproom. One way is to have the pumpman set the valves first, the Officer on watch check them, and the Chief Officer give them the final check. Make sure the sea suction valves in the pumproom are closed and lashed. (NOTE: Sea suction valves may not be chained and padlocked in wartime, they may be lashed only). The setting of valves should be noted in the Deck Logbook and by whom they are checked. It is also a good practice to have valve setting noted in the Pumpman's logbook.

If an inflammable product is to be loaded, boiler fires and galley fires are extinguished. Water-tight doors leading to quarters aft are dogged, also all ports on main deck aft are closed. No smoking or flame of any kind is permitted on board a tanker when loading an inflammable cargo.

LOADING A TANKER

At a loading terminal there is usually a cook shack and a messroom provided on the dock. This is used when an inflammable type cargo is loaded. It is also usual practice to use the dock hoses. In hooking these up, the dock boom is used to swing hoses alongside the ship and the ship boom is used to take the hoses on board. A turn is taken with gantline several feet back of the hose flange. Ships gear is hauled away and dock gear slacked away until hose is lined up with ships risors. Hose is connected to proper risor, a clean new gasket being used. On hoses with aluminum flanges, make sure bolts are inserted from hose flange side and nuts screwed on from risor side, as if nuts are tightend on aluminum flange they will dig into the soft metal ruining flange. Bolts should be set up from opposite sides to get an even pressure all around and prevent leaking and danger of cracking flanges. Drip pans should be in position under hoses at all times. Hoses should be hung off with bridles from ships gear and from dock gear, chaffing mats used. In hanging off a hose, curvature should be kept at a minimum.

When loading is begun, the dock valve should be opened only part way at first. The Officer on watch should inspect tanks where cargo is to be loaded several times in the first few minutes to make sure valves have been set properly, also inspect the pumproom carefully to be sure no leaks have occurred. It is a good practice to have pumproom inspected at regular intervals during entire loading operations. There have been cases where an Officer has neglected this precaution and upon completion of loading operations found that not only were the cargo tanks full of oil but also the pumproom due to a leak or the breaking of a loading line.

When the Officer on duty has assured himself that valves are set properly, and cargo is being loaded into tanks intended, the dock valve is opened wide and loading is increased to normal loading rate.

While loading, certain cargo tanks will have a tendency to load faster than others due to the oil seeking the path of least resistance. This of course will cause the ship to list to one side or the other or come down by the head or stern. The solution to this is to close down part way on the valves in the tanks loading too fast, thus forcing oil into tanks that are loading too slow. Valves should be so manipulated as to keep ship on a fairly even keel. However keep in mind that should it become necessary to shut down loading at any time, the flow of oil into the ship should always be shut off on the dock side of the hose and never on the ships side. To shut off all loading on the hose with the ships valves might easily cause a bursting of the hose.

When a tanker is empty it will be eight or ten feet by the stern, therefore if a cargo of one product is to be loaded, and all suctions on all tanks opened, the oil will run to the lowest tanks, or the #8 and #9 tanks. Therefore, to start loading, #1,#2, and #3 tanks would be opened first and as the ship came up aft, successive tanks would be opened back to #9 tank. When the ship was on a fairly even keel, all tanks would be loading at an approximately even rate.

When a tanker is loading at a dock and the tide is falling, the lines will become slack very rapidly. It is not unusual to heave slack in on the lines twice and sometimes three times on a watch. Particular attention must be payed to slack lines at a dock where there is a strong ebb tide, as at a terminal located up a river. If lines are allowed to become too slack and ship gets off the dock too far, the current and tide may get between the ship and the dock making it very difficult to heave ship into the dock, also if the lines are too slack the surge from a passing ship might easily break a tankers lines or hose, maybe both.

When a tanker is shut down, (as when loading an inflammable cargo) there will of course not be steam available to operate the winches for heaving slack out of the lines, it is necessary, (in case shore steam is not supplied) to shut down loading and fire up the boilers for steam to operate winches. While loading an inflammable cargo or a combustible cargo, loading should be stopped immediately in the following cases:

1. Fire on the dock or on the Ship.
2. Severe electrical storm.
3. Another ship coming alongside same dock.
4. Or in any case where anything out of the ordinary might happen that would endanger the ship.

When loading an inflammable cargo no other dry cargo such as barrels, cases, etc., may be loaded or discharged from the dry cargo hold. This does not prevent the handling of dry cargo while loading a combustible cargo providing the Master, Chief Officer and Dock Supt. agree that it would not be dangerous.

In regards to loading empty barrels into the dry cargo hold; do not accept any empties from the dock unless all barrels have bungs, otherwise gas vapor from the barrels will contaminate the cargo hold. This will necessitate the airing out of the hold before longshoremen will be allowed to enter. Always test the cargo hold with the J. W. Gas Indicator before allowing men to enter it.

When accepting empty barrels for stowage, do not sign for them unless you count them personally. If you do not do this, you may find when discharging that you have signed for a greater number than you really have. In loading full barrels or case oil, reject any that you find leaking.

Topping Off

During loading, temperature of incoming oil should be watched carefully so that it does not exceed maximum degrees allowed by company. Each oil company sets the maximum temperature at which oil may be loaded into an empty ship. The reason for this will be apparent when it is remembered that the part of the ship immersed in the water will closely approximate the temperature of the water surrounding it. If hot oil of an excessively high temperature is loaded into a cold ship, expansion of metal in ships hull will take place inside of the tanks, while the outside of the hull will still be cold. This condition could loosen or pop rivets in a riveted ship or crack welds in a welded ship.

LEADING A TANKER

Topping off of tanks is the procedure by which all tanks are brought up to a predetermined ullage. During this operation the danger of having a spill, or filling the tanks too full, is most acute. A Mate unfamiliar with tanker ships, should have an experienced tanker Mate carry out the topping off procedure with him several times before attempting to do it alone, Each mate will, after gaining experience in this, gradually develope his own system. Until that time however, the following method will be found the safest:

First all tanks should be shut off when they reach a certain ullage, this is before attempting the topping off procedure is started. This ullage can be ten feet or eight feet or any ullage that will give a good margin of safety. The reason for shutting off tanks in this manner will become apparent later.

For example, if it has been decided to leave an 8 foot ullage in all tanks before starting to top-off, the oil in the tanks will not arrive at this ullage all at once, each tank will probably reach this point at a different time. But as each tank does reach eight feet ullage, it is shut off. It is easier to count the ladder rungs down from the deck, than to measure each tank with a tape. Ladder rungs are usually one foot apart so when number eight rung, counted from the top down is covered by oil in the tank, the tank would be shut off.

When on the next to the last tank to be shut off at an eight foot ullage, tell the dock man to stand by to slow down loading rate for topping off. The loading rate is usually slowed down about half the normal loading rate, or more if this is still to fast.

One of the men on your watch is stationed at the valve on the tank to be topped off first, another man is stationed where he can relay orders to the man by the valve. Tanks may be topped off from aft to forward or from forward to aft. They should, however, be topped off in succession so as to keep in mind, what tanks have been topped off.

When the oil in the last tank reaches eight foot ullage, the order is relayed to the man standing by the valve to open it wide. When it is sure he has his valve open, the valve on the last tank to reach eight feet ullage is closed. The dock man is told to slow down loading rate for topping-off, and topping off process has started.

For simplicity it will be assumed that only one product is being loaded in all tanks and that topping-off is being done from number one tank back to number nine. The man who opened the valve that started the topping-off process is standing by the valve, which in this case will be number one tank, port side (there being only port and starboard tanks on #1 tank, all other tanks have to wing tanks and a center tank) The man who relayed the order will, as soon as this is done, stand by the valve on#1 Starboard tank. The Mate doing the topping-off will be watching oil in #1 Port tank or tank with valve wide open.

The ullage that all tanks are to be topped-off at, will of course have been determined before loading was started, this may be six inches under the deck or it may be two feet, depending upon the product loaded. A handy thing to top-off with is an ordinary straight piece of wood about 1" X 2". A cross piece is nailed on this to hold it upright in the ullage hole, the strip of wood should be long enough to reach at least two feet below the deck. It is marked in inches and painted white. When ready for use, it looks exactly like a wooden sword that children make. It will be assumed that the predetermined ullage is to be two feet below deck. As the oil raises in the tank being topped-off, the Mate watches it closely. When oil is about three feet below bottom of the stick the mate gives the order to the man standing by #1 Starboard tank to open the valve two or three turns, at the same time the man standing by the valve on the tank the Mate is watching, closes down on his valve an equal number of turns. The more the valve on #1 Starboard is opened, and the more the valve on #1 Port tank is closed, the slower the oil will raise in this tank. It will of course come into the tank where the valve is being opened faster, as the valve is being opened wider.

The Mate is watching the tank being topped-off and cannot watch the tank where valve is being opened at the same time. However, he knows that the tank had an eight foot ullage before he started opening it, and that it is several feet behind the tank being topped-off. Therefore he knows that he has a margin of safety, and this is the reason why all tanks were shut off at eight feet before the topping-off process began. As the oil in #1 Port tank climbs higher towards the bottom of the topping-off stick, the Mate has continued opening up on #1 Starboard and closing down an equal amount of turns on #1 port. When the oil has only about two inches to climb to reach bottom of stick, the valve on the tank being topped-off should be open only two or three turns. The valve on #1 Starboard tank should be within two or three turns of being wide open. Therefore when oil in the tank being topped-off reaches bottom of the stick, the valve on the tank can be closed very rapidly. The valve on #1 Starboard is then opened wide, the topping-off stick is moved to this tank. The man who has just closed valve on #1 Port tank is shifted to the next tank to be topped-off, after #1 Starboard is finished. In this case he would stand by #2 Starboard wing tank and follow the same procedure that he did in topping-off #1 Port tank. After topping-off #1 Starboard tank, the Mate would top-off #2 Starboard wing tank, then #2 Center tank, then #2 Port wing tank, then #3 port wing tank, etc., back to #9 tank.

When a valve is closed a certain number of turns, another valve is opened an equal amount of turns at the same time. This makes the equivalent of one valve open at all times. Remember, do not shut off all loading against the hose. If you must shut down, it should be done on the deck side of the hose.

Before loading it will have been determined which tanks will be used to bring the ship down to a loaded draft. The tanks that will be left empty, and those that will be filled only part full, will of course depend upon the type and weight of oil loaded.

The amount of cubic feet a ton of a certain specific gravity oil will occupy, together with the amount of barrels of oil it will take to make a ton of weight, will govern the amount of empty or slack tanks, that will be left when a tanker is down to loaded draft.

If slack tanks must be left, (a slack tank is one that is partly filled) it is better to use wing tanks, than it is to leave a center tank slack. The center tanks are large capacity tanks, being over 9000 barrels. When the ship is rolling in a seaway, the unrestricted wash of oil or water in a slack center tank, will put a great strain on the bulkheads. On the other hand, a wing tank being a much smaller tank.

Topping-off--continued

the wash in a slack tank will be restricted to a much smaller surface area.

Unfortunately, it is not always possible to avoid slack center tanks, as at times a tanker may not discharge all her cargo at one port, but may distribute it to several ports, with the fesult that there are bound to be slack tanks on the voyage between ports.

A tanker may be brought down to draft with #2 Tank and #9 Tank, or #9 alone may be used. There are several ways of doing this, and it is best learned on board ship under the direction of an experienced Tanker Mate.

A fact not generally known to Deck Officers,who have sailed only on cargo ships, is that when a tanker ship is in loaded condition it will be sagging from 6" to 8" amidships. This fact should suggest that very close attention be given the Plimsol Mark when bringing down to draft, otherwise an overloaded condition will occur

The same procedure of determining the density of brackish water when loading up a river, on a cargo vessel, is carried out when loading a tanker vessel.

Allowance must be made in each tank for expansion of oil when loading a tanker for a voyage through the tropics. Were it not for the sun shining on the ship's decks and sides, the oil in the tanks would be approximately the same temperature as the water. The sun does shine on the ship's decks and sides, however, so allowance must be made for an increase in the temperature of the oil. From our Pilot Chart we pick out the highest sea temperature that is likely to be encountered during our voyage. To this we add 15° and assume that this resultant figure will be the highest temperature to which our cargo will be subject. We now look in our expansion tables and find out how many barrels expansion we are likely to have in each tank. The amount of barrels expansion known, it is a simple matter to find the amount of additional inches ullage to be left, by refering to the ullage tables.

On tankers equipped with deck sprinklers, the estimated rise in temperature may be reduced slightly, due to the cooling action of the water on the decks.

Remember, when figuring bulk cargo, a barrel of oil is computed as 42 U.S. gallons; the standard temperature is figured at 60°F.,for all oil, irregardless of the temperature of the oil when taken aboard, or the rise of temperature encountered during the voyage.

While carrying oil of low gravity, such as fuel oil, heavy diesel, lub. oil, etc., empty wing tanks and slack wing tanks will occur. In these cases, the expansion of oil can be taken care of by gravitating from a full tank into a slack or empty wing tank.

Loading a Tanker at an Outside Port Through a Submarine Line.

At several places on the West Coast, and at places on the east coast of Mexico, tankers lay offshore from one to three miles, and load through a submarine line. By this is meant a pipeline lying on the bed of the ocean; the loading end marked by a buoy.

Mooring buoys are anchored in place to provide mooring for ship's lines. These are usually placed one abreast each bow, one abreast the stern, and one placed so that a line may be run out the stern quarter chock to it.

A ship maneuvers up well ahead of the buoys and drops one anchor, the chain is payed out freely, the ship maneuvering in the opposite direction from the dropped anchor. The ship's stern is now lined up between the mooring buoys, and the ship brought back between them. As the ship is being brought astern, a line towing boat runs a bow breast line from the windward side to the bow mooring bouy. The line boat then goes aft and runs a stern breast line from thw windward side to the stern breast mooring buoy. Next, the line boat runs a line from the leeward stern quarter chock to the quarter chock buoy. After this is run, the ship is hove back with this line, the propeller not being used. The line boat runs the last line, the leeward bow breast, and the ship is ready to moor in loading position.

If the ship is equipped with a stern loading pipeline, the stern is brought directly over the buoy marking the loading end of the submarine line. If the ship is not equipped for over the stern loading, the hose on the end of the submarine line is taken on board at the midship risors.

In either case, the buoy is taken aboard, and the chain connecting it to the hose is hauled away until the hose is brought up. A long spool with a 90° elbow pointing down is hooked up to the midship risor, or over the stern. The hose is brought up under this, the blind flange removed, and the hose connected to the elbow and spool.

A submarine line is usually filled with water up to the shore tank, and something must be done with this water before loading of oil can be started. The water cannot be pumped overboard as it is contaminated with oil. It is therefore put in the cofferdams, either forward or aft. Upon completion of loading, it may be either pumped back into the submarine line, or carried out to sea and pumped overboard. In case it is carried to sea, water from the sea suctions is pumped back into the submarine line to displace oil in the line.

There is usually a telephone line connected to the hose buoy. This is taken on board with the hose and connected to a telephone on the ship. This is used for communication between the shore and ship. If no telephone line is used, a prearranged set of signals are given on the ship's whistle.

DISCHARGING A TANKER

After a vessel is fast alongside the dock the bonding cable is put ashore and made fast to the shore discharging line. We must make sure that there is metal to metal contact on the "C" clamp. The Mate on Watch, assisted by one man, takes gauges of all tanks, including the temperature of the oil, the amount of water at the bottom of each tank, and, if required, a sample is taken from each tank.

To 'gauge a tank', a steel tape equipped with a plumb-bob on its bitter end is used. The plumb-bob is lowered into the tank until it just touches the top of the oil. The tape is read in feet, inches and quarter-inches at the lip of the ullage hole. Ullages are calibrated from the underside of the deck to the bottom of the tank. The height of the tank trunk may, or may not, have been allowed for. If not, it must be deducted from the gauge to get a true ullage. Tanks are always calibrated for ullages which is the amount of space within the tank not occupied by oil. The innage of a tank is the amount of space within the tank that is occupied by oil. Were the bottom of a ship's tanks smooth, it would be possible to compute the amount of oil in the tank by taking the innage. The bottom of a ship's tanks have longitudinals running fore and aft however, also transverse frames, steam coils, sister keelson, etc. These would make it difficult to determine whether or not the plumb-bob was touching one of them instead of the bottom, when taking an innage.

To 'thieve a tank', or find the amount of water at the bottom of a tank of oil, a brass rod about four feet long is used. The rod is marked in feet and inches, and has a lanyard attached to one end. A chemical paste is smeared on the rod which is then dropped to the bottom of the tank by the lanyard. The rod must be danced around several times that we may be sure it is not resting on one of the aforementioned longitudinals, etc. The chemical paste used does not change color while passing through the oil. It does change color however, upon contact with water. The amount of discoloration on the rod in inches is the amount of water in the tank in inches, directly under the ullage hole.

Remember that although thieving gives the amount of water on the bottom of a tank directly under the ullage hole, this is not necessarily the correct reading for the entire tank. At best it is only approximate as, should the ship have several feet drag by the stern, there will be more water in the after end than under the ullage hole. This is particularly true on T2-SE-A2 tankers where the ullage hole is located approximately amidships of some of the tanks.

'Taking a sample' is done with a clean sample bottle for each tank. A 'v-shaped' section is cut along the side of the cork before it is inserted in the sample bottle. The bottle is placed in a metal holder which is lowered to the bottom of the tank by an attached lanyard. As the lanyard is hauled back slowly the oil will run into the bottle through the 'v-shaped' section in the cork. This gives a good cross-section sample of the contents of the entire tank. Having retrieved the holder and the bottle, the latter is removed from the metal container. The cut cork is replaced by a sound cork and the outside of the bottle wiped off. A tag is next filled out and tied around the neck of the bottle. The information on the tag should contain the date, name of ship, voyage number, product, number and location (port, center or starboard) of the tank, and the name of the port at which sample was taken.

The temperature of a tank of oil is secured by lowering a thermometer by a lanyard to a depth approximately halfway. It should be left in this position long enough to register properly, and then be pulled up quickly and read.

The Officer on Watch has been taking gauges, etc., meanwhile the Chief Mate has been directing the Bos'n and sailors in connecting hoses. As soon as the hoses have been connected and hung off, the valves set and checked, a 'Notice of Readiness' is served on the dock man and signed by him. The ship is now ready to discharge cargo.

Upon receipt of word from the dock to begin discharging, the valve on deck is opened. The Officer on Watch directs the pumpman to start the pumps, a close watch being kept on the pump pressure. Should the pressure rise too rapidly, the pumps are shut down and the ship's valves rechecked. The pumps are re-started, but if the pressure is still excessive they are again shut down. The dock man is directed to recheck all valves on the line into which cargo is being pumped. After the Officer on Watch has assured himself that all ship's valves are set properly, it may be assumed that valves on the receiving line are closed somewhere. Occasionally it is necessary to start and stop the pumps several times before the shore line is unblocked. Remember, While discharging, never exceed the pressure allowed by the company as to do so may burst the hose or blow out low pressure fittings.

Frequently a tanker has a cargo made up entirely of one product. Upon discharging such a load the tanks on the after end should be opened first. A loaded tanker always has a drag by the stern of about two feet. Should all tanks be opened at start of discharge, the after tanks being lower than the forward tanks, the oil would flow aft by gravity and possibly overflow #9 tank. Tanks nos. 8 and 9 should be opened first when starting to discharge. As the ship comes up aft the other tanks may be opened sucessively forward until all the tanks have been opened.

Seldom do two tanks discharge at the same rate as oil will follow the path of least resistance. Should one tank be allowed to empty faster than the other the ship will list either to port or to starboard. This condition is overcome by partially closing, or if necessary, by completely closing the valves on the fast emptying tank allowing the slow tank to catch up.

DISCHARGING A TANKER--Continued.

As discharging of oil continues, the ship will of course be coming up out of the water, and the mooring lines will have to be slacked at regular intervals. If you have a good reliable man on your watch you can allow him to slack off bow and stern lines when needed, without your being with him as you may be busy about deck. However you should allow no one on your watch to slack off on a "Spring" line except under your personal supervision. The "Spring" lines are the only things that are keeping your hose in position, to slack too much on a "Spring", when a heavy tide or current is running, will allow the ship to change position alongside the dock. This could easily carry away your hose.

Also remember to always keep one man stationed by the hose. His duty should be to watch the hose, to slack it away as the ship comes up out of the water, keep chaffing mats in place, and to guard against sharp bends. Oil hoses are very expensive and must receive special care to give maximum service.

After the main part of an oil cargo has been discharged the procedure known as "Stripping" is began. On the old type of Tankers with a midship bulkhead, it was necessary to leave one tank full of oil (usually #6 tank) with which to list the ship to Port or Starboard. A list was necessary to enable the remaining oil in the tanks to flow to the suctions.

On the T2-SE-A1 & A2 Tankers a list is not necessary or desirable. The suction foot is so placed and the hull so designed, that all tanks are best "Stripped" when the ship has no list.

When a tank comes due for "Stripping" (this will be when tops of longitudinals are visible) the main suction is shut off. The "Stripping" suction is opened, and the pumpman directed to start up the steam "Stripping" pump. The tank may be Stripped dry while the main cargo pumps are discharging from other tanks.

The "Stripping " suction valves are known as "Angle stop check valves", (diagram shown in book) this means that when valve is open approximately one and a half turns, the suction of the pump will keep the valve disc off its seat and allow oil to be drawn into line. If suction is lost, the valve disc drops down on the seat and oil in pipeline can not run back into tank.

When "Stripping" a tank it is usual procedure to first open valve wide, and as remaining oil runs to stripper suction foot, the valve is closed down by degrees. "Stripping a tank is done both by eye and by ear. The oil is watched as it runs to the suction foot, and the ear is placed at the ullage hole at regular intervals to detect the pronounced "gurgle" made by the suction valve when air enters along with the oil. Whenever a "gurgle" is heard, the stripper suction is closed down several turns until the noise stops. This means that the suction is again sucking up only oil and not air. If too much air is allowed to enter line, suction may be lost and in this case the pump must be primed from another tank to regain suction. The procedure of looking and listening is continued until the tank is visibly dry. The stripper valve is then shut off and the stripper pump stopped. It is then ready for the next tank to be stripped.

DISCHARGING A TANKER--Continued.

On the T2-SE-A1 & A2 Tankers, the "Stripping" will be done with the steam stripping pump, using the stripping line and valve, whenever possible. The steam pump can be set for a certain number of strokes per minutes, thus giving infinite control.

With a mixed cargo however, it may at times be necessary to use the electric stripping pumps, and strip tanks thru the main suction valves and lines. For instance, if a cargo of two products are to be discharged, one product could be stripped thru the stripping valves, line, and steam stripper pump. The other product could be stripped thru the main suction valves, main twelve inch line, and a electric stripper pump used. This would eliminate the need of washing out the stripping line and pump to prevent contamination of products.

When using the main suction valves, main lines, and electric stripping pumps, it will not be possible to strip the tanks as dry as would be the case were the stripping pump, line, and stripping valves used. The time saved, by not washing out the stripping line and pump will make this method desireable in certain cases.

In several instances, difficulty has been experienced in stripping tanks dry with the stripper pump and stripping line, while the main cargo pumps are in operation. The shore back pressure's were high and main pumps had to be run at pressure's high enough to overcome these back pressure's. The steam pump was called upon to force oil into the main discharge line, at the deck risor connection, against both these pressure's. This situation was highly unsatisfactory, making it necessary to slow down main cargo pumps in order to strip tanks as due.

The solution to this problem would be to install several small hose connection's along the deck "stripping discharge lines". When difficulty is experienced in stripping against main cargo pump pressure, a small hose can be connected to one of these connection's and lead over deck to a center tank hatch. It can then be stuck thru the ullage hole. A tank is then stripped into a center tank of the same product with no back pressure, and the stripped oil discharged by the main cargo pump that would be pumping out the center tank. This method could not be used where the product stripped was an inflameable one. It could only be used on a combustable product.

Remember, that while discharging, the flame screens should be in the ullage holes at all times, except when guaging a tank or stripping a tank. The scupper plugs should be in while discharging, the same as when loading. The red flag by day, and the red light by night should be in position. Fire wire, should be over bow and stern on offshore side, also the portable sign, "No Smoking, No Naked Lights, No Visitors", should be hung at gangway.

As tank cleaning procedure is given in "Tanker Regulations" it will not be repeated here. However, in connection with tank cleaning, is the necessity to test main cargo piping at regular intervals. This can easily be done by taking water from the Port sea suction with the Port main cargo pump. This is pumped into #3 line, then thru the crossover at #7 tank into #2 line, then thru the crossover at #5 tank into #1 line, and then back to pumproom and out of the Starboard sea suction. If Starboard sea suction valve is closed down several turns against the Port main cargo pump, any pressure desired can be obtained All main suction valves must of course be closed.

The main cargo pumps shall be known as starboard - center - port (centrifugal pumps)

The rotary stripping pumps shall be known as port and starboard (rotary pumps)

The reciprocating stripping, bilge, and transfer pump shall be known as the vertical pump (steam pump)

1. Give a short description of the working principles of the tree types of pumps in the pumproom.

   The centrifugal pump must have a flow of liquid to the center of the blades or impellers, as it cannot create a suction or vacuum. After receiving the liquid, the pump whirls at a high rate of speed, creating centrifugal force and ejecting the liquid along the outer rim of the pump to the discharging line.

   The rotary pump is a positive displacement pump. This works along the lines of an eccentric where the rotator with micartar (or similar material) sliding blades first contact the outer ring of the pump at very fine clearance. As the rotator turns, this clearance increases from a few thousandths of an inch to several inches, creating a very positive vacuum. - The discharge of the pump is the same principal in reverse, starting with a large area full of liquid which will be compressed and forced out as the rotator and sliding blades advance.

   The reciprocating pump is a piston pump. Discharge and suction valve manifords work in conjunction with the stroke of the pistons. If the piston creates a vacuum or suction it lifts the suction valve off its seat, allowing the liquid to flow from the line to the pump. On the compression stroke the discharge valve is raised by the pressure created by the piston and the liquid allowed to flow to the discharge line. This is also known as a positive displacement pump.

2. Which type of pump should have the best suction? Next best? Why?

   The rotary pump would be the most efficient in creating a vacuum or suction if it could always operate under ideal conditions. However, any loose scale or rust or dirt between the sliding blades and contacting surfaces will greatly impair its efficiency. The theory of its efficiency is based on its speed, thereby maintaining a more constant suction and discharge. Its cycles of operations per minute would be from 250 up whereas the reciprocating pump would have less than 50, with a slight stop at the top and bottom of each stroke which on occasion may break the continuity of suction, thus losing suction.

   The steam reciprocating pump which would in theory have the next best suction is by far the better pump for general

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2. (con't)

tanker operations. Small dirt particles or other foreign matter in the liquid can be easily handled thru this type without greatly reducing its efficiency. Its slow operation is another good feature as it requires a minimum of care and adjustment and greatly lessens the possibility of scoring the cylinder liners. It is more universally understood and with a little practice, the operator can tell by looking at its operation whether it has lost suction, is pumping hard, etc.

3. Which type maintains the most constant pressure and the least vibration? Why?

The centrifugal pump maintains the best pressure with the least vibration as its revolutions per minute are in the low thousands and every impellor or blade may be considered as a discharge stroke and thereby giving so many impulses per minute that for all practical purposes it may be considered constant.

4. Why should a pumproom be inspected half hourly while loading or discharging cargo? How many persons required to do this? Why?

Inspect the pumproom about every half hour while loading or discharging cargo, for leaks in the pipelines or pumps that may develop thru excessive pressure or vibration or structural failures. Two men should do this, one remaining in upper pumproom so as to observe the other who may slip and become injured or be overcome by gas fumes.

5. Aside from lining up properly, what two inspections MUST be made before loading or discharging cargo?

At least three valves between the sea suction and the cargo lines, port, and starboard sides must be closed and lashed before handling cargo.

All scupper plugs must be properly secured to prevent water polution in the advent of a spill, hose failure, failure to install gaskets between hose and flange, etc. This is the duty of the senior deck officer present.

6. What is the purpose of a master valve?

To provide additional safety and protection of different cargoes by making the isolating of compartments or tanks more certain.

7. What is the purpose of Drop pipes?

In loading mixed cargoes the drop lines make isolation more certain by eliminating the necessity of loading thru the pumproom. In loading a single cargo it is possible, with the aid of the drop pipes, to avoid loading thru the pumproom, thereby eliminating the possibility of any leaks, etc.

8. What pump would you ordinarily use at sea to discharge pumproom bilge? If you could not get suction on bilge, what would you do?

   The steam vertical pump has a separate line from the center of pumproom bilge aft to the forward side of the strainer box attached to suction side of pump.

   Suction can be taken thru sea valves to prime this pump if necessary.

9. If you were carrying three separate grades of cargo, thus (1-2-3-4) (5-6) (7-8-9) how would you strip (5-6) (7-8-9) without contaminating the cargo?

   Tanks (5-6) would have to be stripped with the starboard rotary pump thru the main suction lines and valves. The center centrifugal pump would have to be shut down during this operation.

   Tanks (7-8-9) would have to be stripped with the port rotary pump thru the main suction lines and valves. The port centrifugal pump would have to be shut down during this operation.

10. When loading the after cofferdam, what particular care must be taken with regard to the spilling of oil in the pumproom? Why?

    The bilge suction line hooks into the cofferdam suction line. It is very necessary that the bilge suction valve be closed and lashed while handling oil in cofferdam.

11. Why is it necessary to have two 12" suction lines (crossovers) in pumproom?

    The after 12" suction crossover line is only used for ballasting vessel. During this operation the after crossover is opened to the sea suction, and the valves set so the main pumps discharge into the forward crossover suction lines. Thereby making it possible to discharge all pumps into any desired compartment. At this time it is necessary to have the two suction crossovers isolated, i.e. - all valves between them closed.

12. On the after crossover in pumproom, what objectional feature appears on the stowage plan between the center and port main pumps? How would you correct this in regards to carrying mixed cargo in tanks (5-6) (7-8-9)?

    On the stowage plan it would appear as if there were only one valve between the center and port main pumps, whereas in cargo handling, all valves on the after crossover suction would be closed and an investigation in pumproom will show that two valve protection or isolation is provided.

13. If you were loading thru drop into #5 across with the suctions wide open at the rate of approximately 8000 bbls. per hour, which compartments would ordinarily fill quicker? Why? What would you do to correct this condition?

Due to the installation and the momentum of cargo, the wing tanks would fill quicker than the center tank. Aside from these features, a small tank would fill quicker than a large one, if the rate of flow is the same for both. It will not fill in direct ratio to its size because of increased pressure or resistance encountered as its level exceeds the larger tank. The port wing will therefore fill quicker than the starboard wing as the cargo would have to travel the least distance, and the starboard wing would fill faster than the center tank, because it is a smaller compartment with the same size loading line. This can be corrected by partially closing the valves on the tanks to the desired rate of flow.

14. Why is it desirous to have the liquid level approximately the same in all compartments of one tank?

To avoid listing ship or putting unnecessary strain on the bulkheads.

15. If this ship could carry a gasoline load of approximately 141,000 bbls. with all compartments full and the gasoline weighed 8 bbls. to the ton, would it be in order to load fuel oil weighing 7 bbls. to the ton to 87½% capacity in all compartments? Why?

It is never desirable and is poor seamanship to carry all compartments partially full. In this case it would be necessary to isolate four wing tanks and keep them empty. Preferably 2 and 9 wings. Then partially fill #6 wings to desired draft or quantity. The correct tanks to remain empty or partially full would necessarily vary according to the amount of bunkers and water aboard and weight of cargo and the stowage. Ordinarily the ship would be loaded to between one and two foot trim by the stern.

16. In what tanks do the (1-2-3-4) (5-6) (7-8-9) suction lines interconnect? To what advantage in loading? Discharging? (Assuming same cargo in all tanks)

Tanks (1-2-3-4) and (5-6) suction lines are separated by two master valves in #5 center tank. Tanks (5-6) and (7-8-9) suction lines are separated by two master valves in #7 center tank.

The advantage in loading would be the elimination of the necessity of loading thru the pumproom into any compartment, assuming the loading hose was amidships and one cargo was carried.

The advantage in discharging would be slight, normally, but perhaps to great advantage in the event of a leak in the suction line between tank and pumproom in line regularly used.

17. If the starboard and port rotary pumps can be connected to the main suction lines, what is the advantage of having a separate stripping line and valves?

The separate stripping line is small and the suction located at the most advantageous places in compartments to pump them dry. The main suctions and lines can be opened and drained into the compartments and this drain stripped out with the small line, ensuring a minimum of water or cargo remaining in the system.

18. Is a list to any advantage in stripping this vessel? Why?

A list is to no advantage as the shape of the hull provides proper flow to all suctions. It is to be avoided when discharging as the liquid will not flow to the suction on the low wing tank or center tank.

19. If this vessel carried gasoline in 2-9 inclusive, and bunker fuel in #1 tank and fore deep tank and fresh water in fore peak, tell what pumps you would be required to use to discharge or transfer same. What procedure would be highly desirable before loading?

Before loading it would be necessary to blank off all suction lines and stripping lines between #1-2 tanks. It would also be necessary to block the suction and discharge lines between the port and center pumps in forward pumproom. - To discharge #1 and the fore deep, the center pump forward pumproom would be used (separate suctions on forward end of #1 tank) discharging this along the deck transfer line to bunker tank or where required. - To discharge fresh water in fore peak the port or outboard pump would be used, discharging into fire line to be transferred aft or where required. - The cargo in 2-9 inclusive would be discharged in the usual manner.

20. Why is a hydrometer a necessary part of a ship's equipment?

Tankers often load where the water is partially fresh, such as the upper end of San Francisco Bay, or even farther up river, For a vessel to attain her proper sea draft (Salt Water) it is necessary to take a density test with a hydrometer approximately an hour before finishing loading so as to determine how much additional draft is desired. If a vessel has a 10 inch fresh water allowance and the density is 1.013, the additional permissible draft would be 5". If it requires 67.0 tons to increase draft 1" she can load an additional 335 tons. If cargo was fuel oil weighing 6.5 bbls. per long ton, she could load an additional 2177.5 bbls. This is very important when loading to draft and the volumetric capacity of the tanks is not the governing factor.

21. If you were loading gasoline cargo at 60° temperature and bound for Panama, would it be advisable to load tanks to deck level? 2 feet below? 4 feet below? What method would you use to determine the correct ullage? (assuming ship could carry full cargo)

21. (con't)

Allow 15° above the highest sea temperature likely to be encountered in route (see hydro. charts). If the highest sea temperature for this time of year was 85°, add the 15° to it and look up the expansion factor between 60° and 100° for this grade of cargo and from the ships tank tables leave out a corresponding proportion of cargo in each compartment. Thus when the vessel arrives at the warmer part of her voyage the cargo level in the tanks would be expanded to what had been a pre-determined safe level.

22. On the stowage plan on Pumping Facilities there is a Note saying: Tanks cannot be loaded thru strupping line due to suction valves being stop checks.

What is a stop check? What is the purpose of the drop line on #2 tank into the stripping line?

The stop check is a valve designed to permit the flow of liquid in only one direction. The main purpose of the drop line on #2 into the stripping line is in having a method of flushing the stripping line when gas freeing vessel.

23. What is the purpose of the two 2" pipes located in the upper side of the 3 main centrifugal cargo pumps? Where does each lead?

These 2" pipes are a means of pumping out, with the stripping pumps, any remaining liquid in the ships pumps or lines.

On the starboard main pump they lead to the vertical stripping pump.
On the center main pump they lead to the starboard rotary stripping pump.
On the port main pump they lead to the port rotary stripping pump.

24. If you were given loading orders for approximately 115,000 bbls. of fuel oil to mean draft of 32' 0" and trim by stern not to exceed 1' 6" how would you go about loading this vessel?

Load 2 to 8 center and 3-4 and 6-7 wings across to the usual safe outages and when these were finished start loading into 2-5-8 port and starboard wings, observing draft and trim from wharf and regulating trim on these compartments so that when 1' 6" by the stern.

25. Why should you know the number of tons required to increase the draft 1 inch at loaded draft?

So that you would have some idea of additional cargo required if loading in brackish (partially fresh) water.

INSTRUCTIONS FOR THE USE OF THE BUTTERWORTH METHOD OF TANK CLEANING

The Butterworth apparatus is made by the Butterworth System Inc. of Bayonne, N.J. It is used on Tankers to wash cargo tanks, to free tanks from rust and scale, and to assist in the gas freeing of tanks.

When the problem is to convert a vessel from black oil to refined oil, a great degree of cleanliness is required, Thin streaks or films of heavy oil, wax or residue, entirely safe as regards gas regeneration or flammability, must be removed to bare metal, and all black oil must be worked out of seams, under rivet heads and structural framing and in every crevice, pocket and corner. It is never possible to completely remove such occluded deposits by any amount of steaming or hand hosing, and they must generally be dissolved and washed out by a penetrating cleaning oil.

To gas free a vessel it is necessary to heat the tank atmosphere sufficiently to facilitate rapid ventilation. It is also necessary either to heat the metal sufficiently to evaporate the adhering light oil, or to wash away all such free oil and pump it out. As soon as the light oil has been evaporated or washed and pumped away, the vapors can be readily be removed by natural ventilation while the tank atmosphere is warmer than that of the outside air.

Use of the Butterworth System for even a very short time (one hour or less) in a tank results in heating up the tank atmosphere sufficiently for natural ventilation, and also results in washing down all free, light oil to the pump suction from which it is continously removed with the wash water. Loose scale will be knocked down in this short time, exposing free oil adhering to the hard scale or metal surfaces. It is neither necessary nor desirable to turn steam into a tank to heat up the metal or tank atmosphere when using the Butterworth System, and it is unnecessary to do any hand hosing in a tank or even open the hatch while washing by the Butterworth Method. The Butterworth machine is simply inserted through the hole located centrally in the tank for this purpose, which is closed with a portable plate when not in use. The vessel should be trimmed, if necessary, to facilitate complete stripping. The deck opening is closed by the flange on the Butterworth hose supporting device, which fits the same joint as the blank plate. When a deck vapor system of piping is fitted and if hatches and ullage covers are kept closed, vapors generated due to rising temperature of tank while washing will be found to escape through an elevated outlet with falme arrestors at the mast. By this means, it is possible to keep all escaping vapors off the deck when washing with the Butterworth System.

Gas freeing for Shipyard overhaul or to permit work in tanks by members of the crew requires a very thorough condition of cleanliness. In this case it is necessary to wash longer in each tank, or at least 1½ hours, to insure that all loose scale is knocked down and ground up into fine bits, which will permit the oil to be leached out and pumped away, together with most of the scale. Any scale remaining will be safe from explosion, as all light fractions will have been leached out by hot water; however this scale should be removed.

The Butterworth System is a method of washing the inside surfaces of tanks without sending mean into the tanks until after they have been cleaned and ventilated. Steaming of tanks, with the attendant release on deck of explosive mixtures of oil vapors and air, is eliminated when using the Butterworth Method.

By the Butterworth System a mechanically rotated nozzle device attached to the end of a hose is inserted through a hole cut in the deck. This hole is sealed by a plate on which the hose supporting device is mounted, and by a plain blank plate when machine is not in use. The nozzles turn slowly in horizontal and vertical planes, so that their positions change continually with each revolution, causing the streams to be eventually directed or deflected against all surfaces. Those areas not struck directly are washed by splashing from adjacent surfaces. Those areas not struck directly are washed by splashing from adjacent surfaces or members. As the motion of the two balanced jets is controlled with mechanical precision, a much more thorough job of washing is done than would be possible by hand. Furthermore, with hand washing it is not possible to utilize the high pressure (175 lbs. per sq. inch) or the high temperature (165° F. to 185° F.) which are used in washing with the Butterworth System.

The most important single consideration is the pressure available in the fire main at the hose connection to washing machine. This should be 175 lbs., and if less pressure is available, the effectiveness of washing will be reduced in an almost direct proportion. The washing action depends on two different principles. First, the quantity of water thrown, which is important since the oil residues must be heated and washed down to the tank suction. Second, the force with which the jet strikes the tank walls, which determines its power to dislodge or tear loose oil, wax, scale and bottom accumulations.

When the Butterworth machines are in place in tanks and hose is connected up to fire main, with valves open and all other preparations completed, send word to engineer to put hot water pressure on the fire main. 175 lbs. pressure and 165° F. (temperatures as high 185° F. may be advisable if tank has previously carried very heavy oil) on deck, gage and thermometer must be maintained for efficient cleaning. From time to time while washing, the mate should check the deck guage and thomometer readings, to insure that these necessary conditions are being maintained.

On vessels with wing bulkheads (or three rows of cargo tanks abreast, with no summer tanks), it is necessary to wash the center tanks when the vessel is upright, but it may be necessary to heel ship to properly strip wing tanks.

After washing a tank for the required time, if permissible, open the hatch immediately to ventilate. If desired, especially when a breeze is blowing, drop a windsail duct nearly to the bottom of the tank and trim the sil into the wind. Since ventilation depends on temperature, the tank should not be allowed to cool off before ventilation. While ventilating, precautions to prevent sparks on deck should be redoubled.

INSTRUCTIONS FOR OPERATING, CARE AND MAINTENANCE

This type machine is connected directly to the Butterworth special grounded high pressure hose and passed through a hole in the deck, being lowered to any desired depth, without the use of pipe fittings. It is held in place by a clamp on a special quadrant deck plate. The machine is self-contained and requires no motor or other independent means for turning, all the mechanism being inside and well protected. It is simple in construction and made as nearly foolproof as possible. The complete machine, weighing less than 60 lbs., can be handled by one man. All parts of the machine are made of bronze, monel metal or beryllium copper. The revolving nozzle unit and the revolving lower body have bronze roller bearings. The worm has bronze ball thrust bearing. Other bearings are special bronze bushings or thrust washers.

The nozzles are rotored by the flow of water passing through a turbine which is enclosed in the body of the nozzle unit. The water entering the machine from the hose is deflected by a cone-shaped cover having vanes on the outboard circumference directing the flow of water through the impeller vanes. The revolving impeller imparts power through a crankshaft, ratchet and worm to turn or release the nozzle unit. Before lowering a machine into tank to be sure that it is securely attached to hose.

If machine should fail to operate when water pressure is turned on, we suggested the following procedure: Oil all moving parts. Rotate the impeller unit with screw driver in slot provided for that purpose in the lower end of crank. By this means, it can be determined whether or not the machine turns freely, failure to do so will be due, probably to an obstruction in some of the water passages. By this test it can be determined whether or not the pawl is properly engaging the ratchet. This can be noted by observing the worm which should turn slightly forward at each revolution of the crank. If when making this test it is found that the crank turns freely, and that the worm and nozzle unit turn properly, the trouble, probably, will have been due to an obstruction in either the nozzle or water inlet housing.

To determine whether or not the trouble is due to the last mentioned cause, remove and inspect both nozzle tips and if necessary, remove inlet housing at flange by taking out six 3/8" bolts. If the trouble is not found, and for further inspection, first remove the nozzle unit, worm gear and nozzle gear, by taking off the nozzle thrust bearing. Inspect and clean thrust bearing rollers that may have become clogged with salt or scale. Inspect nozzle pintle bushing for possible excessive wear. Inspect gears for possible damage.

Next remove ratchet housing by taking out six 3/8" cap screws. This will expose for inspection the entire ratchet units, including crankshaft, pawl spring, ratchet and worm assembly. See that crank turns freely in bearings, that pawl spring is properly adjusted, and that wormshaft turns freely in bearings. Spring can be adjusted or renewed by simply loosening cap screw No. 35. Remove crank assembly by taking out two 3/8" cap screws, inspect crank thrust washer and renew if badly worn. Thrust washer should be renewed when worn to 1/16" thickness. To remove thrust washer, it necessary to first drive out lower crank bushing. Excessive wear of crank thrust washer might permit the crank or impeller to drop below operating level.

Next remove, for inspection and cleaning, main pintle roller bearing assembly. Inspect main pintle bushing for possible wear. Next remove guide vane head assembly and impeller, to determine whether or not the impeller is touching the housing or guide vane head, and to determine the condition of the upper impeller shaft bushing.

Broken or improperly adjusted pawl spring, or excessive crank journal bushing wear, would cause the failure of ratchet to revolve when crank is turning. To correct, it would be necessary to adjust or renew spring, crank journal bushings or pawl assembly. Excessive wear in main pintle roller bearing would cause end of pintle to bear on top of crankshaft. Excessive wear of nozzle thrust bearing might result in worm gear improperly meshing with worm. Excessive wear of upper impeller shaft bushing would cause binding of impeller blades on housing.

If after making the above inspection, and correcting any faults mentioned if found, the machine still fails to operate when assembled and tested, the trouble undoubtedly will have been due to some damage caused by rough handling that has resulted in a sprung pintle or worm housing. The latter might possibly be corrected on board ship, but a sprung pintle would be difficult to determine and the machine should be returned to the Butterworth System Incorporated.

This machine is ruggedly constructed, but it should be realized that reasonable care must be exercised to prevent damage by rough handling, such as dropping on deck or swinging against tank structure. Butterworth System Incorporated will not be responsible for repairs necessitated by any cause other than ordinary wear and tear or defective parts.

To eliminate possible danger from static electric sparks, only hose that is provided with ground wire between the two end couplings should be used for delivering water to the machine.

Provision should be made on board vessel for securely stowing machines when not in use. After the completion of each cleaning operation, and before stowing away, the machines should be flushed with fresh water to remove salt deposits, then oiled to prevent the accumulation of verdigris. This last can best be done by dipping the entire machine in a bath of oil.

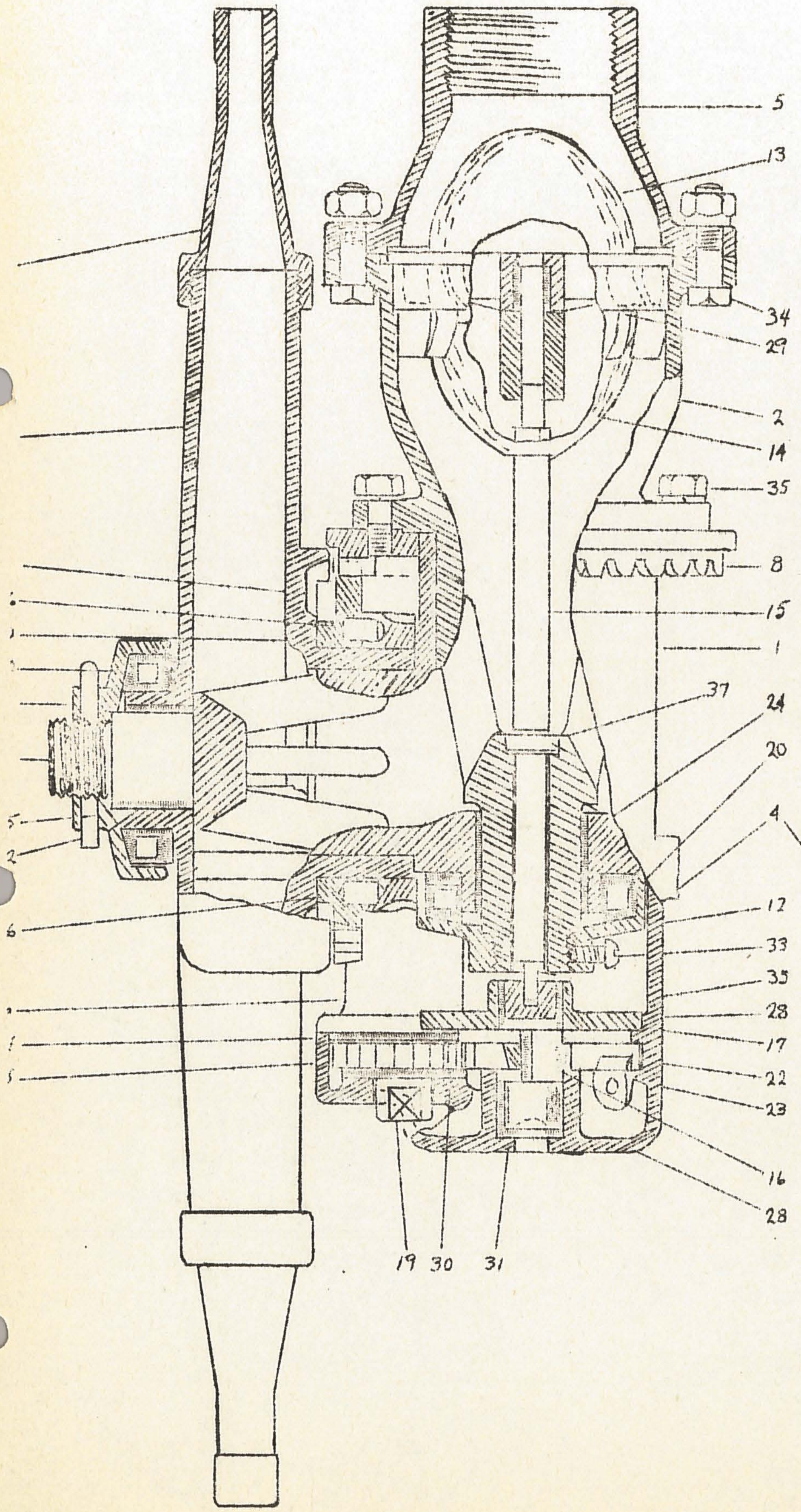
Butterworth tank washing machines are made entirely of non-ferrous metals, thereby eliminating danger of sparks due to the machines coming in contact with any part of the tank.

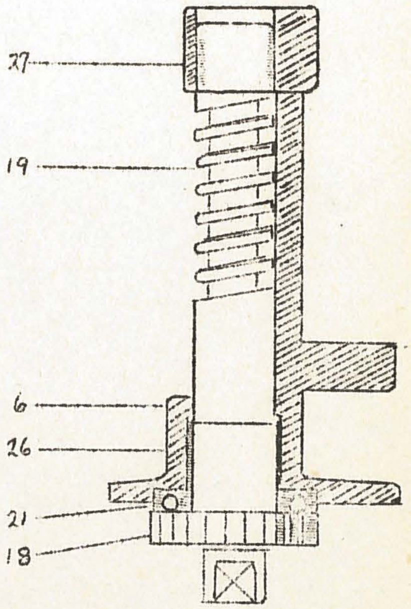
Note: Ownership. The Butterworth tank cleaning method and machines are available to vessel owners on a royalty rental contract, the tank cleaning machines furnished remaining the property of Butterworth System, Inc., Bayonne, New Jersey.

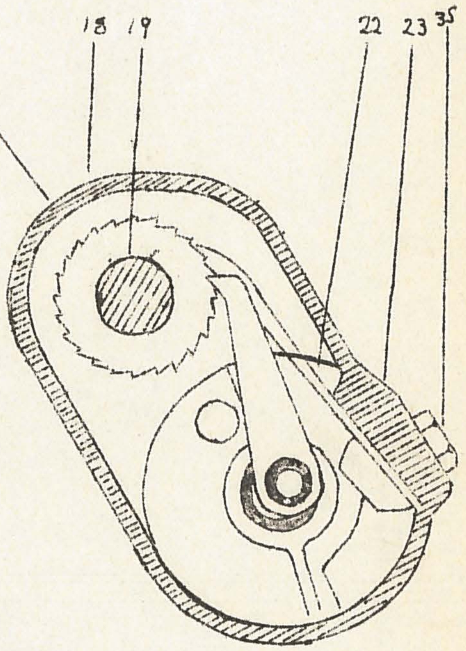
LIST OF PARTS

Part No.	No. of Pieces	Description
1	1	L-Housing
2	1	Spindle Housing
3	1	Nozzle
4	1	Ratchet Housing
5	1	Inlet
6	1	Worm Housing
7	2	Nozzle Tip
8	1	Stationary Gear
9	1	Nozzle Gear
10	1	Worm Gear
11	1	Nozzle Thrust Nut
12	1	Spindle Thrust Nut
13	1	G. Vane Head Assembly
14	1	Impeller Assembly
15	1	Impeller Shaft
16	1	Crank & Pawl Assembly
17	1	Crank Bearing
18	1	Ratchet
19	1	Worm
20	2	Roller Bearing Assembly
21	1	Ball Bearing Assembly
22	1	Pawl Spring
23	1	Spring Clamp
24	1	Spindle Bushing
25	1	L-Head Bushing
26	1	Lower Worm Bushing
27	1	Upper Worm Bushing
28	2	Crank Journal Bushing
29	1	Upper Shaft Bushing
30	1	Worm Thrust Washer
31	1	Crank Thrust Washer
32	1	Cotter Pin
33	1	Set Screw
34	6	3/8--16 Screw & Nut
35	7	3/8--16 Cap Screw
36	4	Pin
37	1	Washer
38	5	3/8--Cap Screws (Not shown in Drawing)

TYPE "C" BUTTERWORTH WASHING MACHINE







J-W. COMBUSTIBLE GAS INDICATOR
Made by
JOHNSON-WILLIAMS, LTD. PALO ALTO, CALIF.

The J-W Combustible Gas indicator is a handy, portable instrument which makes it easy to measure the content of combustible gas or vapor in air. When drawing lean mixtures thru the Indicator, it gives a continuous reading of the concentration directly in terms of "nearness to explosive". A red numeral "I" designates the "lower explosive limit", or the mixture which contains barely enough gas or vapor to be explosive. If it is desired to test mixtures within or above the explosive range, a Range Multiplier may be used which brings such mixtures within the range of the instrument. The Indicator may be used with entire safety on any mixture of combustible gas with air.

The Indicator comprises one light, compact unit which may be used without accessory equipment. For examining remote locations, sampling hose of the required length may be quickly attached.

To make an analysis:

1. Turn on switch and adjust voltage to red line.
2. Work Aspirator Bulb to suck sample thru the Indicator. If combustible gas is present, the Indicator meter hand will rise and show the gas concentration. It will take four or five squeezes of the bulb to thoroughly flush the reaction chamber and get an accurate reading on a new sample. For precision the reading should be taken just after pumping is stopped. If the hand should rise past the figure "I" to the top of the scale it simply means that the gas is explosive or richer and beyond the usual range of the Indicator.

The sample enters the Indicator through the Sampling Cock as the Aspirator Bulb is allowed to expand. Each time the bulb is squeezed and expanded, or "worked", the Explosibility Meter will fluctuate slightly, This movement occurs under all operating conditions and is proof that the instrument is functioning properly.

When pure air is drawn thru the instrument, the explosibility meter hand should come to rest at zero. The zero setting should be checked each time the instrument is put into operation. Before altering the zero setting, make sure that the meter hand deflection is not due to residual gas. If it is necessary to set the zero reading, the left hand or "adjuster" knob is pulled straight up (to engage the clutch) and turned.

Where samples are to be taken from remote locations, constricted openings, or inaccessible spaces, it is necessary to use sampling hose. Place the end of the sampling hose at the point from which the sample is to be taken and operate as above. About three additional squeezes of the bulb are required to flush each five feet of hose used. For instance, with a fifteen foot hose, the bulb must be compressed fourteen or fifteen times before sample being analyzed is the same as the sample being drawn into the end of the hose. To check the zero adjustment when sampling hose is attached, turn the handle of the Sampling Cock straight up. This closes off the sampling hose and opens an air hole at back of the cock.

When a mixture of air and combustible gas or vapor is brought in contact with a hot platinum wire, rapid combination of the combustible with the oxygen of the air takes place at the surface of the wire, raising the temperature of the wire, and consequently increasing its electrical resistance.

In the J-W Indicator, this change in resistance is made to actuate a sensitive meter. The reaction chamber and filament are so designed that with an increase in concentration of combustible, a proportional increase in resistance of the platinum wire takes place. Consequently the amount of combustible present is indicated directly by the meter. Two platinum filaments are mounted in protecting tubes inside a substantial metal reaction chamber. Samples of air containing combustible gas vapor are drawn continuously through this chamber when the rubber aspirator bulb is operated. One protecting tube is sealed against admission of air-gas mixture under inspection. while the other, being open at both ends, acts as a chimney to circulate the mixture past the filament in that tube. It is at the surface of the filament of this open tube that the oxidation of the gas takes place. The filament in the closed tube compensates for the variable temperature conditions under which the instrument must operate, such as minor variations in voltage.

The indicator meter (left side) is equipped with a special scale which shows a yellow "Dangerous" range, and a red "Explosive" range. The "Dangerous" section begins at .2 (representing about .3% by volume of gasoline vapor). This point represents a factor of safety of 5 with respect to the lower explosive limit, which allowance is considered essential to the safety of containers on which hot work is to be done. The "Explosive" point , I.0 , represents the leanest mixture which will burn (or explode) if ignited, or the "lower explosive limit". The decimal numbers indicate concentration of gas in terms of the amount necessary to form this lower explosive limit mixture. For instance, when the indicator meter stands at .3, the reading is "three-tenths explosive". If the vapor sample is too rich to explode, the indicator hand will first swing sharply to the red end of scale, and will then fall to zero, giving no further indication. What happens is that at first the instrument contains some air or a lean mixture, which mixes with the incoming vapor to give a vigorous heating effect on the filament, causing the meter to register. As the supply of air is diminished, the oxidation rate drops rapidly and the filament cools off.

Since the life of the batteries is limited, the current should be turned off except when the instrument is in actual use. When it is necessary to turn the rheostat all the way to obtain the required 2.0 volts, the batteries should be replaced. Exhausted batteries should be removed promptly.

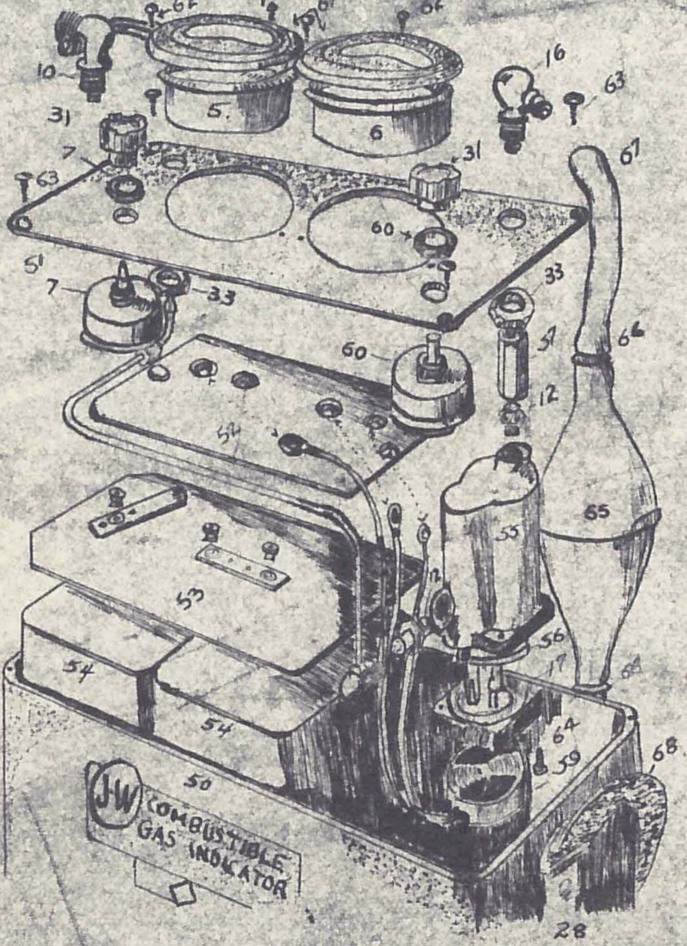
On both the inlet and outlet side of the reaction chamber and forming sections of the sampling line itself, are short lengths of brass rod drilled longitudinally with very fine holes. These serve the purpose of arresting any flame which may originate in the reaction chamber. If dust or lint is repeatedly drawn into the instrument, the fine holes in the arrestors, particularly the arrestor on the sampling cock side of the reaction chamber, may become plugged. Usually this can be cleared out by reversing the rubber aspirator bulb and using it to blow violently thru the hose nipple and out the sample cock. Dry compressed air up to 75 lbs. per sq. inch may be employed if necessary. If this fails, the reaction chamber and flame arrestors must be removed and the holes cleaned out with a fine wire. The holes must never be enlarged. Use great care in replacing the arrestors and chamber to see that the assembly goes in gas tight again

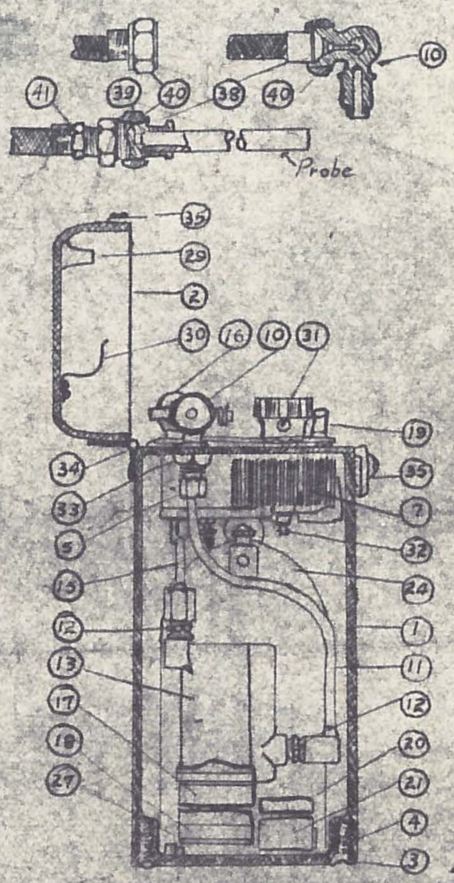
DESCRIPTIVE PARTS LIST
EXPLODED VIEW

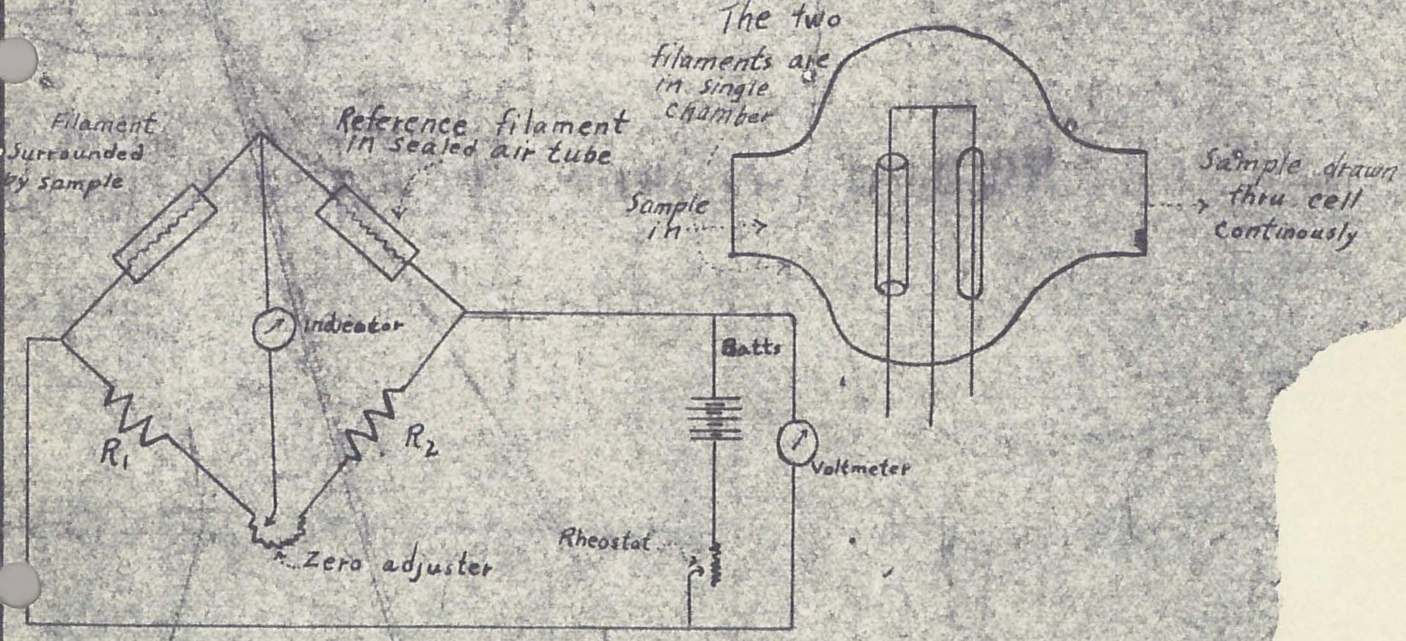
5	INDICATOR METER
6	VOLTMETER
7	ZERO ADJUSTER AND CLUTCH
10	SAMPLE COCK
13	FLAME ARRESTOR
16	TUBE NIPPLE
17	FILAMENT UNIT
28	STRAP DEES
41	KNOB
44	LOCK NUT
50	CASE
51	COVER
52	SUB-PANEL
53	BATTERY CONNECTOR
54	BATTER, BURGESS 4FH
55	REACTION CHAMBER
56	REACTION CHAMBER LINER
57	EXTENSION SLEEVE
58	CONNECTOR TUBE
59	FILAMENT JACK
60	RHEOSTAT AND SWITCH
61	METER GUARD
62	METER SCREWS, No. 4-40 ROUND HEAD
63	COVER SCREWS, No. 6-32 OVAL HEAD
64	FILAMENT SCREWS, No. 8-32 ROUND HEAD
65	ASPIRATOR BULB
66	ASPIRATOR BULB VALVES
67	ASPIRATOR BULB TUBING
68	SHOULDER STRAP

DESCRIPTIVE PARTS LIST
SIDE VIEW

1	CASE
2	LID
3	BOTTOM PLATE
4	BOTTOM GASKET
5	INDICATOR METER
6	VOLT METER
7	ZERO ADJUSTER
8	RHEOSTAT
9	BALLAST COILS
10	SAMPLING COCK
11	CONNECTOR TUBE No 1
12	FLAME ARRESTOR
13	REACTION CHAMBER
14	CHAMBER LINER
15	CONNECTOR TUBE No 2
16	TUBE NIPPLE
17	FILAMENT UNIT
18	FILAMENT JACK BLOCK
19	BATTERY SWITCH
20	BATTERY JACK
21	BATTERY JACK BLOCK
22	DRY CELLS
23	BATTERY BOX
24	BATTERY BOX COVER PLATE
25	BATTERY BOX COVER INSUL.
26	BATTERY BOX INSULATION
27	BATTERY BOX CLAMPS
28	STRAP DEES
29	SHUT OFF LUG
30	BULB CLIPS
31	RHEOSTAT KNOBS
32	ZERO ADJUSTER CLUTCH
33	PANEL LOCK NUTS
34	HINGES
35	LOCK
38	HOSE UNION, MALE HALF
39	HOSE UNION, FEMALE HALF
40	HOSE UNION, NUT
41	HOSE UNION, CONNECTOR






Filament Surrounded by sample
Reference filament in sealed air tube
Indicator
R1
R2
Zero adjuster
Batts
Voltmeter
Rheostat
The two filaments are in single chamber
Sample in
Sample drawn thru cell continously

"Wheatstone Bridge" Circuit.

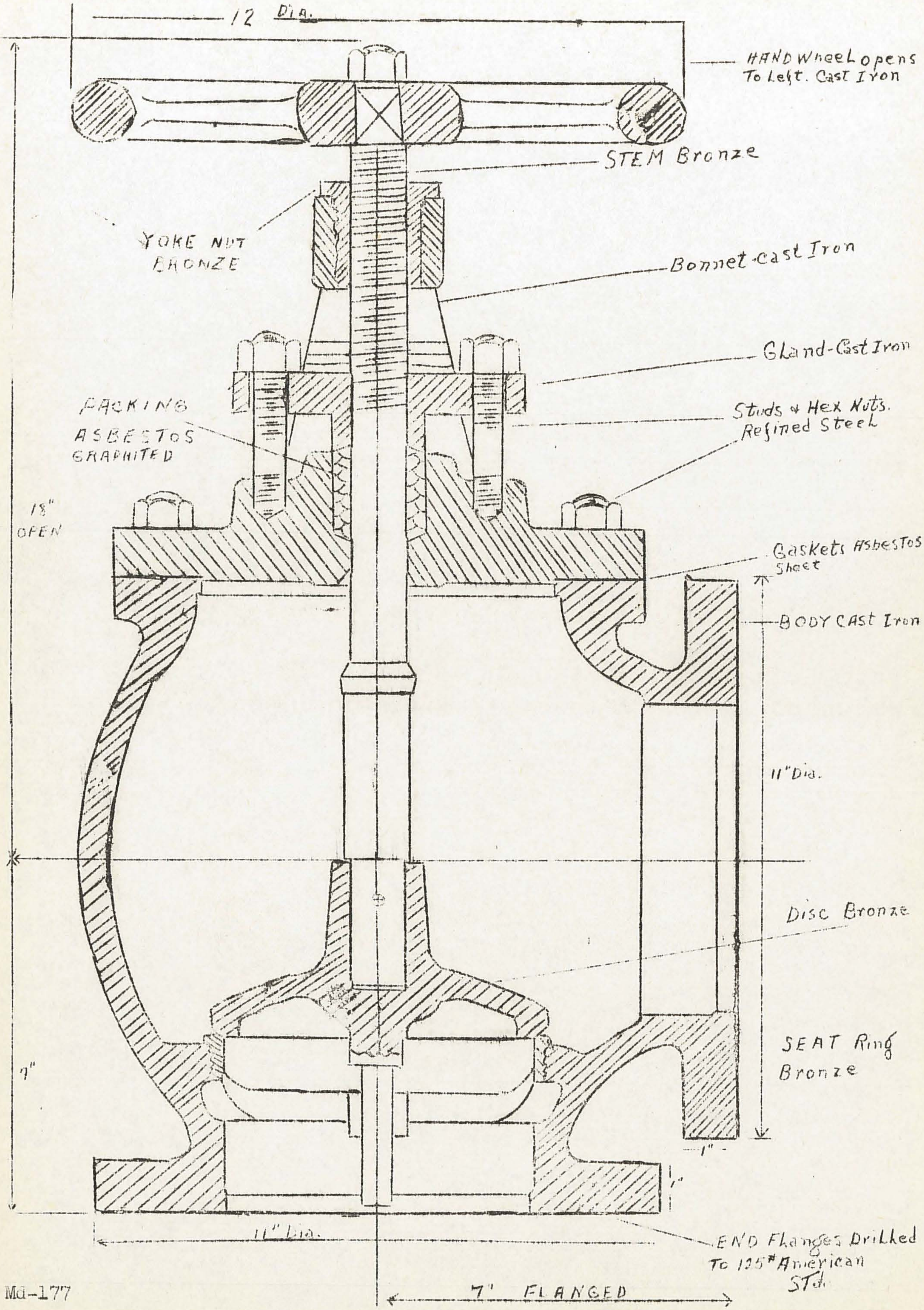
ANGLE STOP CHECK VALVE

Made By

THE KENNEDY VALVE MFG. COMPANY

ELMIRA, N.Y.

This valve is used on all stripping suctions. When valve is open approximately one and a half turns, the suction of the pump will keep the valve disc off its seat and allow oil to be drawn into line. If suction is lost, the valve disc drops down on the seat and oil in the pipeline can not run back into tank.


12 DIA.
HAND Wheel opens To Left. Cast Iron
STEM Bronze
YOKE NUT BRONZE
Bonnet-cast Iron
Gland-Cast Iron
PACKING ASBESTOS GRAPHITED
Studs & Hex Nuts. Refined Steel
18" OPEN
Gaskets Asbestos Sheet
BODY CAst Iron
11" Dia.
Disc Bronze
SEAT Ring Bronze
7"
1"
1"
11" Dia.
END Flanges Drilled To 125# American STd.
7' FLANGED

Md-177

ROLAGRIP PIPE COUPLING

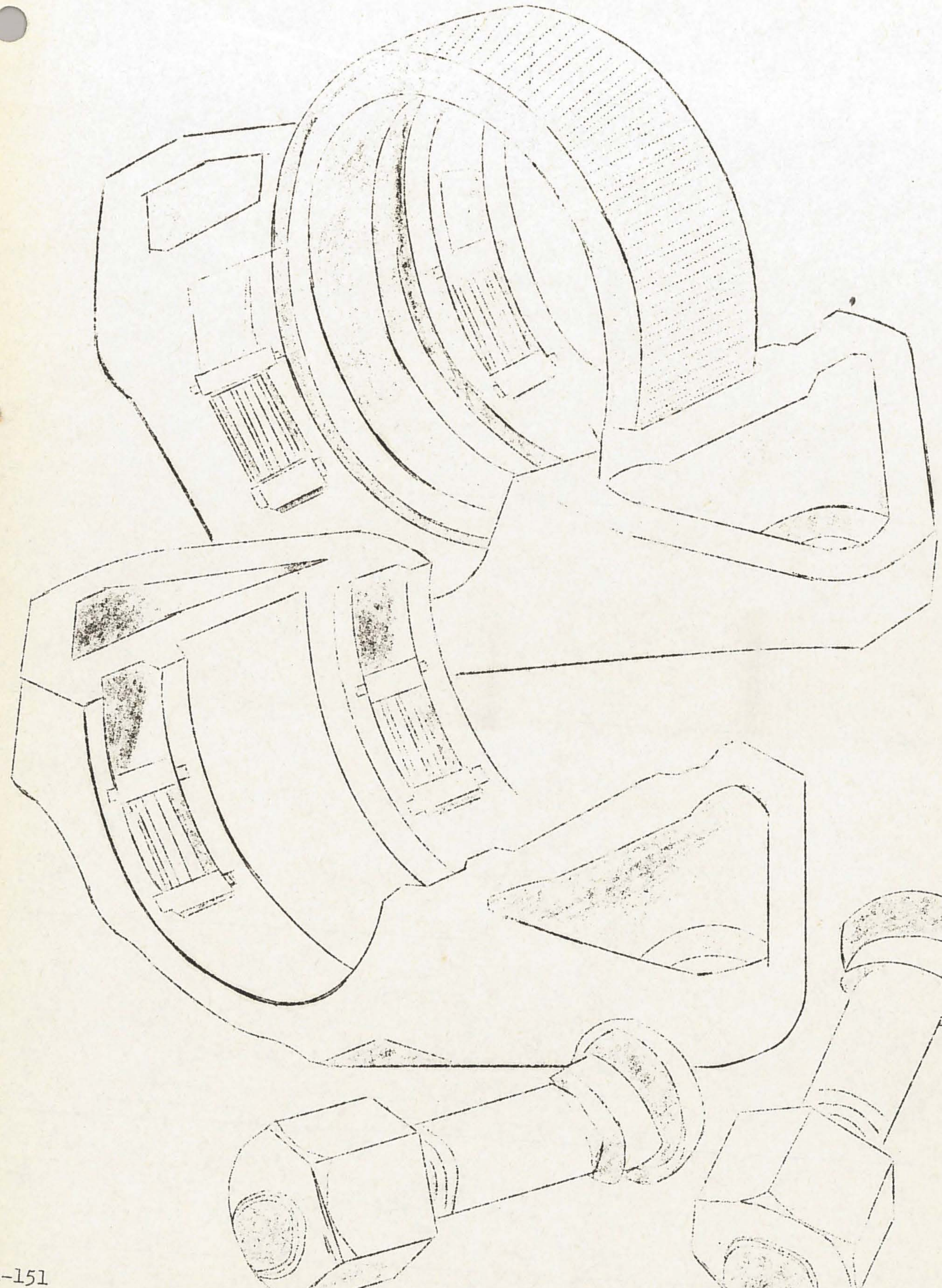
The Rolagrip pipe coupling are used extensively on the T2-SE-A2 tankers; on main loading and discharge lines, both on deck and in cargo tanks; on vent lines and stripping lines. The coupling allows for expansion and contraction, and also for movement of pipelines caused by the working of the ship. In Fig. 1, the steel rollers are held securely in place by means of a keeper bar at each end, permitting just sufficient travel to bring into full force the gripping action. In Fig. 2, the extra wide resilient gasket is compression-sealed. Comparison of the black outline with the dotted outline shows how the housing forces the gasket lips against the pipe for leak-proof sealing. In Fig. 3, the steel rollers grip as they roll; the greater the pressure the tighter the grip. Position at installation shown in black. In Fig. 4 the interchangeable housings are shown. The use of Rolagrip couplings eliminates threading and flanging of pipes; however, misalignment of pipe should not exceed 5°.

Rolagrip pipe couplings are made by the Gustin-Bacon Manufacturing Co., of Kansas City.

Two diagrams are shown. With only three parts to place in position and two bolts to tighten, Rolagrip affords the simplest and fastest method of joining pipe for leak-proof connections. By using plain end pipe, Rolagrip eliminates time-wasting threading, grooving and flanging operations.

When tightening bolts on Rolagrips, care must be used to set up on bolts evenly, as otherwise the gasket may be forced to one side, making an imperfect seal.

Rolagripspipe couplings have been officially approved by the "American Bureau of Shipping", "Lloyd's Register of Shipping" and other Governmental Agencies.



Md-151

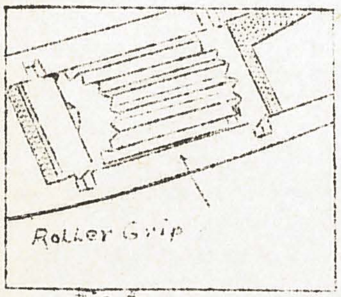


FIG. #1

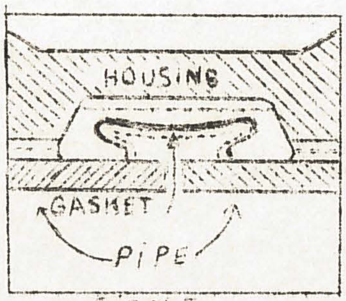


FIG. #2

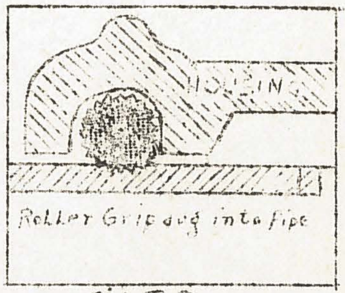


FIG. #3

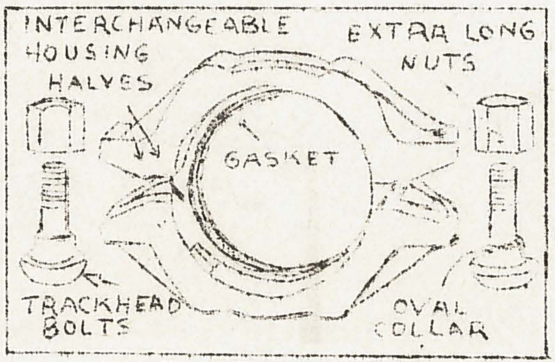


FIG. #4

VENT SYSTEM
COMBINATION PRESSURE AND VACUUM VENT VALVE

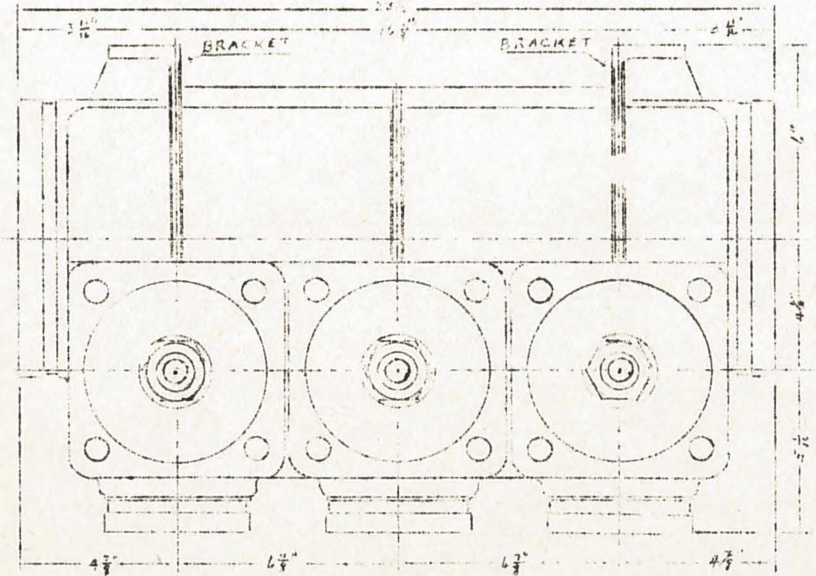
This is the first unit in the vent system. The pressure and vacuum valve is installed in two ways. On all tanks with the exception of # 1 tank, the valve is installed in a series of three and is called the "Special Triplex". This means that there are three pressure and vacuum valves combined in one case. This takes care of three tanks.

On # 1 tank the valve is in a single series only, and there are two seperate valves for Starboard and Port tanks on # 1. Two diagrams are shown, one of the "Special Triplex" and one of the "Special Single".

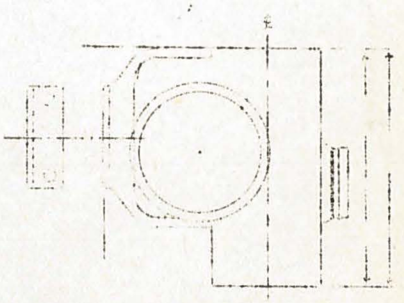
These valves are set for 2.0 lbs. per sq. in. on the pressure side of valve, and for 1.0 lb. per sq. in. on the vacuum side. If pressure exceeds this amount the pressure will force cylinder up and allow pressure to escape to vent system up mast, or if vacuum exceeds 1.0 pound pressure the vacuum part of valve will operate and relieve vacuum.

These valves are fitted with a lifting gear and spindle making it possible to mechanically operate valve, increasing capacity to 3.0 lbs. per sq. in.

Md-151



PLAN VIEW



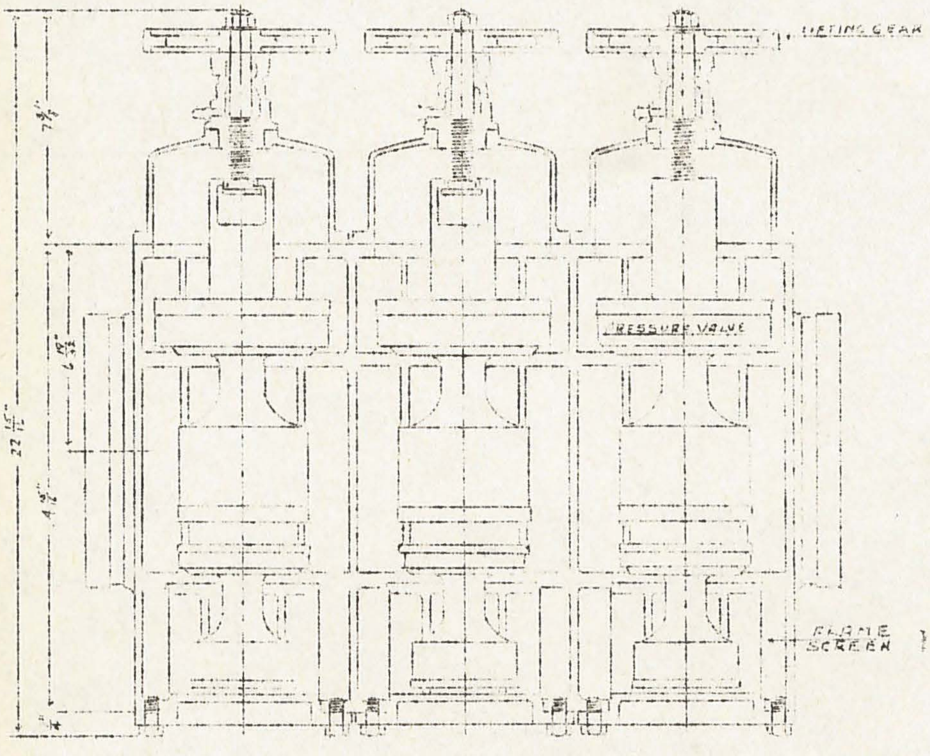
END ELEVATION

NOTES

SKELETON PRESSURE VALVE SHOWN OPENS AT 2.0# PER SQ IN SPINDLE HAS CAPACITY FOR THREE 0.5# TYPE HEAD DISCS SO OPENING PRESSURE MAY BE INCREASED TO 3.5#

VACUUM VALVES UP TO 1.5 LB. PER SQ. IN. MAY BE FITTED.

UNIT APPROVED BY
BUREAU OF MARINE INSPECTION & NAVIGATION.
AMERICAN BUREAU OF SHIPPING
LLOYDS REGISTER.



VERTICAL LONG'L SECTION ON VALVE C.L. TAKEN OFF CENTER

PRESSURE-VACUUM RELIEF VALVE

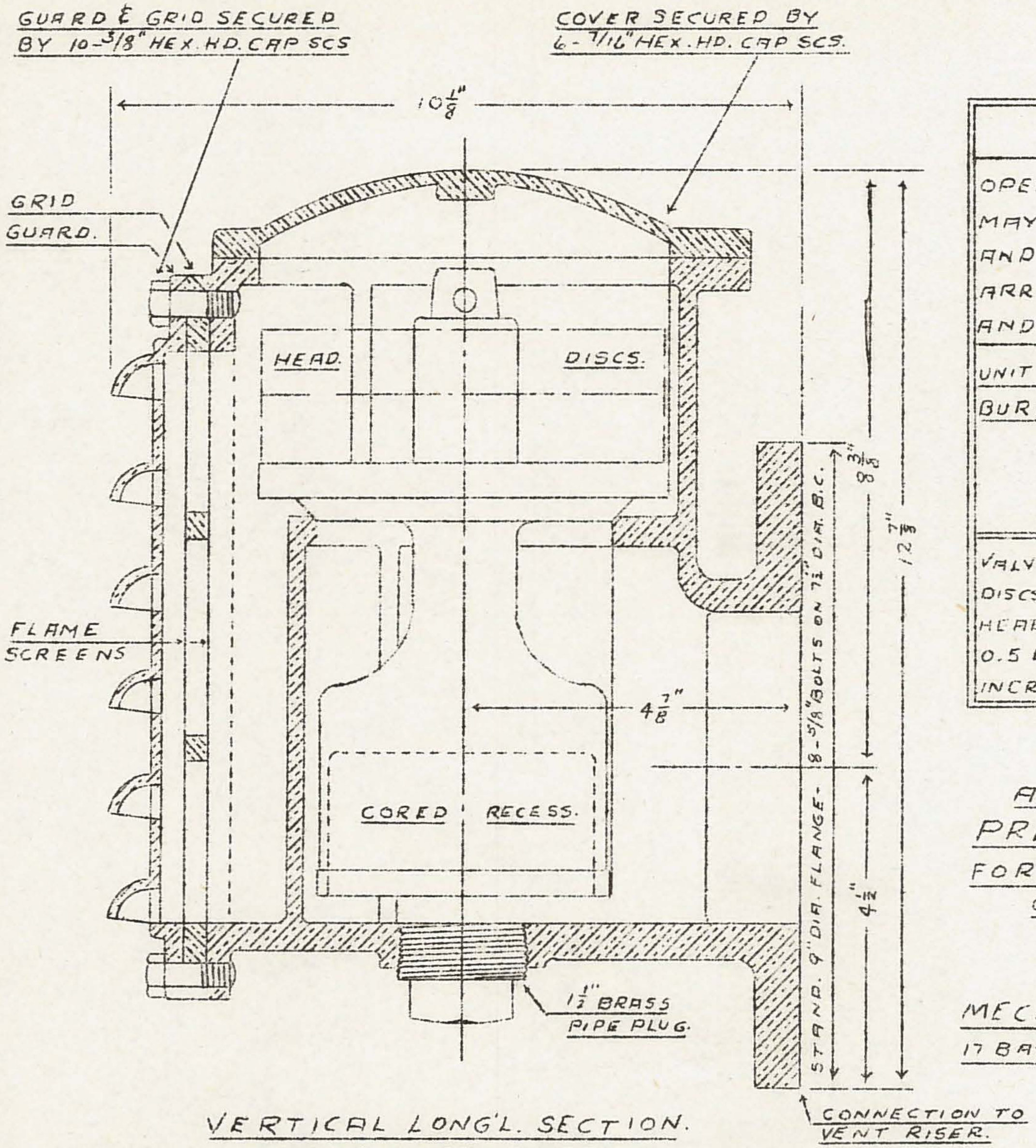
Nº 3-F-4IN. SPECIAL-TRIPLEX.

VAC-REL VALVE
PAT. 12-5-33
#1,938,162

VENT SYSTEM
EMERGENCY PRESSURE RELIEF VALVE

This valve is installed on the vent pipe leading up the mast and in case the "Flame Arrestor" at the cross trees becomes plugged up, it operates automatically, and vapor from tanks is discharged through this emergency relief valve.

There is also a spectacle located on the vent line leading up mast directly above this valve. The blank end of spectacle is inserted in case the "Flame Arrestor" bank is withdrawn for cleaning.


GUARD & GRID SECURED BY 10-3/8" HEX. HD. CAP SCS
COVER SECURED BY 6-7/16" HEX. HD. CAP SCS.
$10\frac{1}{8}"$
GRID
GUARD.
HEAD.
DISCS.
FLAME SCREENS
$4\frac{7}{8}"$
CORED RECESS.
$1\frac{1}{2}"$ BRASS PIPE PLUG.
STAND. 9" DIA. FLANGE - 8-5/8" BOLTS ON $7\frac{1}{2}$ DIA. B.C.
$8\frac{3}{8}"$
$12\frac{7}{8}"$
$4\frac{1}{2}"$
CONNECTION TO VENT RISER.

VERTICAL LONG'L. SECTION.
TAKEN OFF CENTER.

NOTES.

OPENING PRESSURES UP TO 2.5 LBS. PER SQ. IN. MAY BE ARRANGED WITH SOLID TYPE VALVE AND FULL AREA SEAT. HIGHER PRESSURES ARRANGED BY USING SECTIONAL TYPE VALVE AND SEPARATE SEAT OF RESTRICTED AREA.

UNIT APPROVED FOR GRADE "A" PET. R. PRODUCTS BY
BUREAU OF MARINE INSPECTION & NAVIGATION.
AMERICAN BUREAU OF SHIPPING.
LLOYDS REGISTER.
PANAMA CANAL COMMISSION.

VALVE AS SHOWN OPENS AT 1.0 LB. PER SQ. IN. DISCS FASTENED BY 5/16" MACH. SCREWS FITTED ON HEAD OF VALVE EACH INCREASE OPENING PRESSURE 0.5 LB. OMISSION OF CORING IN TAIL OF VALVE WILL INCREASE OPENING PRESSURE 0.5 LB. PER SQ IN.

ALL BRONZE-WEIGHT LOADED
PRESSURE RELIEF VALVE.
FOR INSTALLATION IN VENT RISERS
OF CLOSED VENT SYSTEMS.

FEB. 6, 1940.

MECHANICAL MARINE CO.
17 BATTERY PL.-NEW YORK CITY.

VAC-REL
VALVE.
PAT DEC 31, 1938
No. 1,026,163

№ 2-R-4 IN.

Md-151

VENT SYSTEM

The 8" Oceco Flame Arrestor is the third unit in the vent system. It is placed on the vent pipe at the masthead and as the name implies, it is for the purpose of arresting flame.

The Flame Arrestor elements or "banks", have been made entirely of aluminum and the two lower corners of the housing are supplied with aluminum wearing angles on which the "bank" slides when it is withdrawn for periodic inspection.

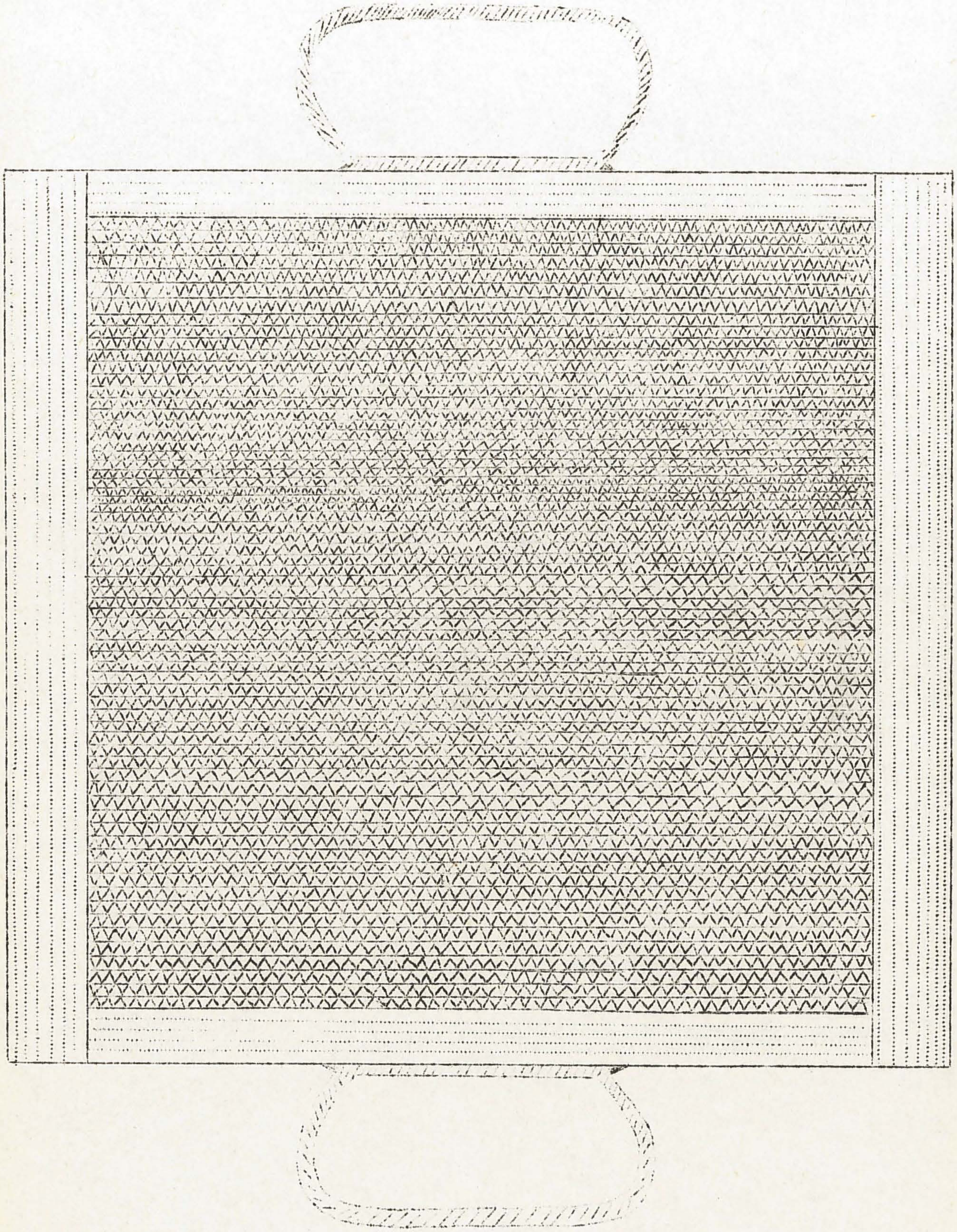
The "bank" itself consists of an assembly of alternate flat and corrugated aluminum sheets, which are assembled between two aluminum plates and held in this assembly by means of four aluminum tie rods.The four corners of the "banks", are covered by aluminum angles which are fastened at each end to the end plates by means of aluminum screws. The back cover of the housing is attached to the housing itself by means of steel cap screws. The front cover which is the one which is removed for a periodic inspection is held to the housing by means of malleable iron wing nuts which tighten on bronze studs. The use of bronze studs is necessary since bronze is a non-sparking material and eliminates the possibility of developing a spark when the cover is being removed.

The Flame Arrestors manufactured by the Johnston & Jennings Co. of Cleveland, Ohio have been approved by the Underwriters Laboratorie Inc. Two sectional diagrams are shown.

The housing and its covers are substantial semi-steel castings. In the event the flame arrestor is exposed to the intense heat of a sustained fire, the high melting point semi-steel castings provide heat resistance and protection to the low melting point aluminum arrestor element. This protection is not possible with aluminum housings. The melting point of semi-steel is approximately 2300 deg. F., while the melting point of aluminum is about I200 deg. F.

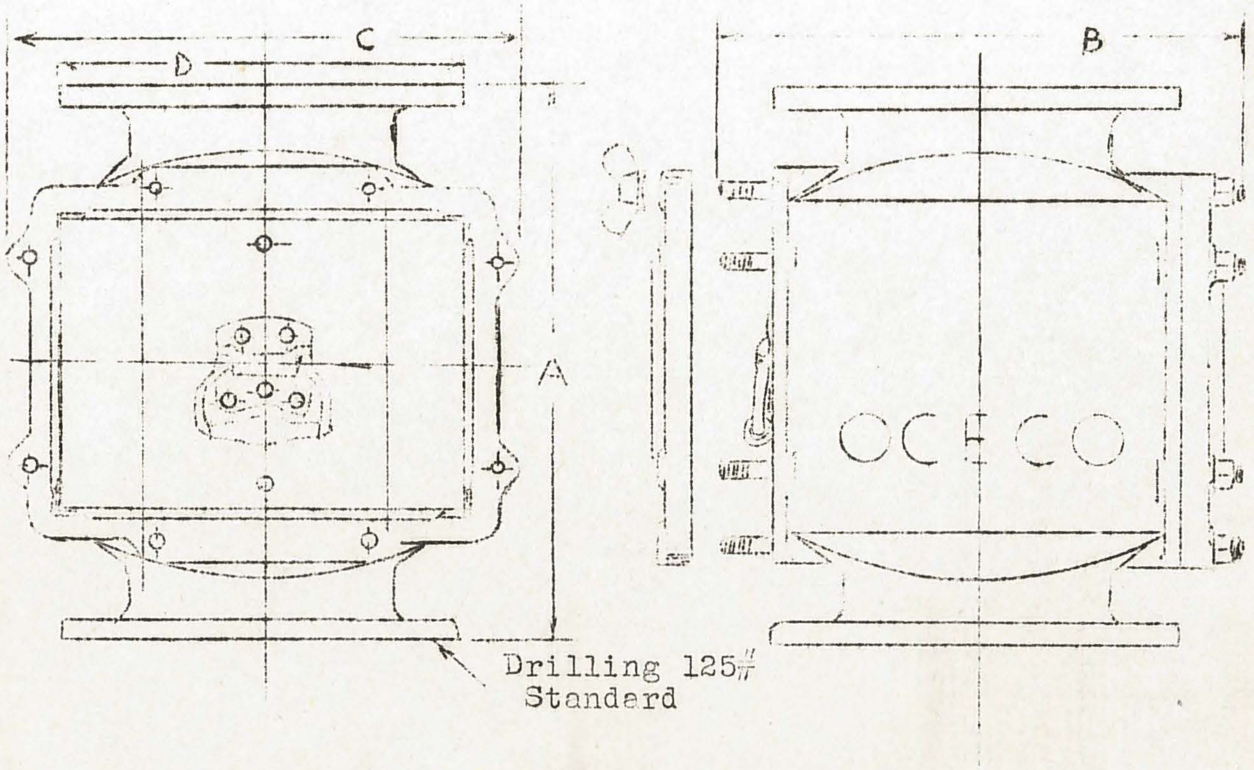
While the Oceco flame arrestor element, because of its straight through passages, has less tendency to clog than other designs, there are some services in which the vapors, containing gummy substances, may foul the passages. In such cases, inspection should be made at shorter intervals, so that the passages may be cleaned before they are entirely closed.

OCECO Flame Arrestor Bank



8" & 10" FLAME ARRESTORS

Oceco Division--The Johnston &
Jennings Co.--Cleveland Ohio



Drilling 125#
Standard

SIZE	A	B	C	D	BOLT CIRCLE	HOLES NO.DIA.	WEIGHT LBS.
8"	21¼	17	16-3/4	13½	11-3/4	8-7/8"	360
10"	24½	21¼	21	16	14-1/4	12-1"	575

COMPILED BY CAPT. ALLEN CAMERON

Under present conditions many vessels have been operating away from the continental limits of the United States for extended periods of time. During such operations, they have probably received loading instructions telegraphically from their Home Office, through their loaal agents or through representatives of the Lend Lease Administration, the U. S. Navy or other Governmental authority.

In such circumstances, these instructions are necessarily brief and perhaps at times even confliction. Thrown upon your own resources, as you have been on many occasions, your handling of the various problems connected with loading and discharging your vessel has indicated a good deal of thought and creditable action. We would, however, like to call your attention to certain points which may from time to time be overlooked.

In laying out cargoes fro your vessel you should endeavor to load the maximum cargo possible for the voyage yoy are undertaking, which quantity is determined by your requirements for carriage of sufficient bunkers, water, stores, draft limitations, etc. The cargo should be so distributed in the vessel that no excessive strains will be introduced. When loading a full cargo of gasoline, all compartments should be filled to capacity except the wing of No. 5 or No. 6 tank. The outage left in these tanks tends to reduce the amount of sag characteristic in loaded tank vessels.

When carrying full cargoes of fuel oil, it is suggested that alternate wing tanks, starting with No. 1, be left enpty rather than leaving large outages in the fore and aft sedtions of the vessel.

Your vessel has been supplied with the United States Coast Guard publication "Load Lines", outlining regulations for the establishment of load lines for merchant vessels of 150 gross tons or over. Of particular interest to your vessel, are the provisions outlined under Part 48, Foreign Voyages During the National Emergency, Pages E-119 and E-120, and specifically Paragraph 48.4, which points out that "your vessel may: (a) When in summer zone or season, load to the Tropical Load Line. (b) When in the tropical zone or season, load to the Tropical Fresh Water Line".

In connection with the above, We suggest you review the two Load Line Certificates with which your vessel has been provided. One of these Load Line Certificates is applicable only to coastwise voyages and is so marked. The other certificate indicates the freeboard you must have when making voyages other than those of coastwise character.

On the inside back cover of the Load Line Book is a chart of the World showing various zones and seasonal areas which affect the drafts of vessels. You willnote that the Netherlands West Indies Islands are within an area marked "Seasonal Tropical", ie. From November 1st to July 15th, the area is Tropical. From July 16th to October 31st, the area is classified as Summer.

A waiver has recently been issued by the Coast Guard which declares that loading at ports on the coast of South America within this area be governed by the Tropical Zone when the vessels are bound for Pacific combat areas. As you know, the Tropical Load Line Mark on your vessel is 30' 9½". The fresh water allowance is 8¼". Therefore, at all times of the year when loading in this area, you may load to your mark of 31' 5 3/4".

Instrudtions have been issued by compteent authority that all vessels proceeding to forward combat areas are to carry a full capacity of fresh water and use their evaporators to supplement their daily consumption. When your destination is a forward combat area, unless instructed otherwise by your agent, you should plan to leave B alboa with approximately 800 tons boiler and culinary water, Since the fresh water supply at Caribbean Loading ports is extremely limited, it is suggested that you depart from Cristobal with only sufficient water and adequate reserve to allow you to proceed to your loading port and return to Panama. Upon arrival at the Canal Zone on your return voyage, you should arrange to supplement your fresh water to give you the desired capacity upon sailing. Your draft on departure from Balboa, of course, is not to exceed the legal limitation of 31' 5 3/4".

From time to time, vessels have been instructed at Panama to load cargo of fresh water for discharge at their oil loading terminal. When this occurs, you must bear in mind that this cargo is of a commercial nature for which the Company is reimbursed and all voyage papers are to be compiled and forwarded to this office in the same manner as though petroleum products had been loaded and discharged. It is extremely important that the number of barrels and tons of fresh water cargo actually loaded and ultimately accepted by the consignee, be indicated. The reason for non-acceptance of any cargo should be also clearly stated.

During the completion of loading in a zone such as the Persian Gulf, which is always Tropical, consideration of bunker and water consumption must be given to the draft of your vessel for the time you will enter a zone which requires an increased freeboard. For example, a vessel proceeding from Bahrein Island to Colombo, Ceylon, between May 21st and September 15th or October 16th and November 30th, will enter the Seasonal

Summer Zone in the vicinity of latitude 24° North and / or Longitude 59° East. This position is approximately 500 miles or 1 ½ days run from the loading port, and upon arrival at the new zone, your drafts must not exceed 30' 9½". Therefore, your maximum draft on sailing from Brahrein on a T2-SE-A1 vessel, would be approximately 30' 11".

At a number of world ports, the depth of water is such that deep draft vessels are prohibited from entering at over certain specified drafts. Where these conditions exist, Masters will be advised by their office or other competent authority. In such cases, extreme care must be used to insure the limiting draft is not exceeded.

The draft and trim of the vessel may be computed at any point of the voyage by revising the original loading computations, making corrections for the number of tons of bunkers, water and stores consumed and the change of any masses of weights that occur, such as transfer of bunker fuel oil from the fore deep tank to the wing bunker compartments of the tranfer of water from forward aft.

Roughly speaking, the T2-Se-A1 type of vessel at approximately loaded draft rises bodily .9" per day from the consumption of bunkers, water and stores, and changes trim approximately 6"; ie., assuming the vessel sails on a loaded draft of 29' 9½" forward and 31' 9½" aft, or on a Mean Tropical draft of 30' 9½", and burnes from the after bunker tanks only, at the end of two days steaming at sea, the vessel would trim on an even keel drawing 30' 7.7".

The T2-SE-A2 type vessel rises bodily out of the water, approximately 1.2" per day and changes trim approximately 8".

The above figures are only approximates and do not hold true when the vessel is trimmed excessively by the head or stern, and vary as the draft of the vessel becomes less.

For your ready reference the following table will indicate the approximate tonnage required to be transferred from one compartment to another to change the total trim of the vessel 6" when the loaded draft is 30' 9½". Twice the tonnage will change the trim approximately 12". However, when greater tonnages are moved or greater changes in trim required, a separate computation should be make, using the figures indicated on the trim scales attached to the loading calculations.

Tons required to be moved to change trim 6":

From Fore Peak tank to After Peak tank	26.2 tons
" " " Deep tank to Wing Bunker tanks	35.5 "
" " #1 tank to #9 tank	43.8 "
" " #2 tank to #9 tank	48.1 "

(Cont.)

From #2 tank to #8 tank	56.1 Tons
" " #2 tank to #7 tank	67.3 "
" " #2 tank to #6 Tank	84.2 "
" " #3 tank to #9 tank	56.0 "
" " #3 tank to #8 tank	67.1 "
" " #3 tank to #7 tank	84.0 "
" " #3 tank to #6 tank	111.9 "
" " #4 tank to #9 tank	67.2 "
" " #4 tank to #7 tank	111.9 "
" " #5 tank to #9 tank	84.0 "
" " #5 tank to #8 tank	111.9 "
" " #4 tank to #8 tank	84.0 "

This table was computed as follows:

The term "Moments" is used to express a foot tons relationship, that is, the result of multiplying a weight by a distance to indicate a forde. Briefly, a weight of ten tons placed 100 feet from a basic point, such as the After Perpendicular, exerts a force of 1,000 Moments or foot tons.

The Moments to alter trim 1" at 30' 9½" are 2.043. Since it is desired to change the trim 6", this figure is multiplied by six, which gives a total of 12,258 Moments. The actual distance that the weight is moved, ie. Center of Gravity from one compartment to another compartment is divided into 12,258 Moments. For example, the Center of Gravity of #1 tank is 418.7 feet from the After Perpendicular. The Center of Gravity of #9 tank is 138.6 feet from the AP. The distance between the Centers of Gravity of these tanks by subtraction is 280.1 feet. 12.258 divided by 280.1 equals 43.8. the number of tons required to change the trim of the vessel 6".

LOADING CALCULATIONS

The draft and trim of a T2 tanker can be readily computed with the information attached to these instructions and with only a slight knowledge of the intricacies of naval architecture.

The principal points to bear in mind in loading the vessel are that each unit of material placed aboard the vessel increases the draft by the amount of the weight of the material and affects the trim of the vessel in direct relationship to its distance from the After Perpendicular of the vessel, which point is the zero position in all measurements concerned in these problems; ie. 67 tons placed at any position aboard the vessel will increase her Mean Draft 1" when the Mean Draft of the vessel is 30 feet. However, if that amount of weight is placed in #9 tank, the trim aft will be increased approximately 3.78", or if placed in #1 cargo tank, the trim

(Cont.)

The trim forward will be increased approximately 5.43" forward. The reason for this is thar when placed in #9 tank the Center of Gravity, which is 138.6 feet from the After Perpendicular, the 67 tons represents a foot tons ratio of 67 tons times 138.6 feet or total Moments of Weight of 9.286 foot tons while if placed in #1 tank, the Comter of Gravity of which is 418.7 feet from the After Perpendicular represents a foot tons ratio of 67 tons times 418.7 feet or total Moments of Weight of 28.053 foot tons. From this comparison, it is apparent that the weight placed in #1 tank has more than three times as much leverage from the stern of the vessel as weight placed in #9 tank.

The computatuon of the trim of a vessel is simply a sumnation of the forces or weights aboard the vessel expressed in foot tons or Moments of Weight treated as one item and compared with the displacement of the vessel in tons multiplied by the Longitudinal Center of Buoyancy, which figure is called the Moments of Displacement. The difference between these figures divided by the figure given as Moments required to trim 1" represents the total trim of the vessel.

DEFINITIONS:

L. C.B. - Longitudinal Center of Buoyancy - this is the point measured along the horizontal length of the vessel at which the vessel would balance in equilibrium if placed on a fulcrum. The weight aft of this point is exactly equal to the weight forward of it. As cargo is placed in a vessel, the position of this point moves forward. The T2-SE-Al light Ship L.C.B. is 215.0 ft. and the L.C.B. at Tropical Draft is 253.1 feet.

CB - Center of Byoyancy - The Center of Gravity of the vessel. This always coincides with the Lonitudinal position of the L.C.B. which is measured in a horizontal direction only. The CB in addition to this occupies a position above the keel and inboard from the sides of the vessel. The exact point around which all forces are in equilibrium.

AP - After Perpendicular - A verical line at the after edge of the stern post.

FP - Forward Perpendicular - A vertical line at the bow, at which point the load water line intersects the stern.

C.G. - Center of Gravity - The exact Center of any mass or the point around which a mass will act.

)O(- Longitudinal Center of Vessel, or one half the distance between AP and FP.

PROBLEM:

Required to compute before loading, the draft and trim of a T2 Tanker loading in the San Francisco Bay Area with 175 tons package goods in cases on deck and balance cargo, 100 Octane Gasoline for discharge in the Southwest Pacific Area, loaded draft to be to Tropical Load Line Marks of 30'9½".

PROCEDURE:

1. Arrange work in columns as shown in attached example. (A) List in sequence all compartments and positions aboard the vessel in which cargo, bunkers, water, stores or other weights will be placed or are fixed. List prodicts and materials to be loaded.

(B) This column is of primary use when a mixed cargo is being carried.

(C) Note the outage to which each tank is to be loaded. This figure represents the gross amount and allowances made therein for any exception that may occur as a result of transitting tropical waters.

(D) In column (D) the quantity to be loaded in net amounts is indicated. This figure is used in the next column to determine the number of tons in the compartments. Unless the product being loaded is at a temperature of 60° F. there will always be a difference between the outages indicated in column (C) and the net amount shown in column (D).

1. The net amount is obtained by multiplying the gross quantity by the coefficient of expansion of the product as explained in paragraph 2 below.

(E) Entries in column (E) are obtained by dividing the number of barrels per ton applicable for the product being loaded by the not quantity to be loaded in that compartment.

1. The b/t figure may be obtained from the U. S. Maritime Service Tanker Mates Handbook if the gravity of the product is known or from the Shore Representative at the loading terminal.

(F) In column (F) list the Centers of Gravity of the compartments as shown on the Capacity Plan (Plate 1) attached.

(G) The figures in column (G) are the Moments of Weight. To obtain this figure, multiply the tons (Column E) by the Center of Gravity (Column F).

2. All computations of cargo are based on a temperature of 60° F. If cargo is above or below this temperature, it is described as Gross and must be changed to Net. This is done by multiplying the quantities by the Constant Multipliers contained in Appendix 1 to the Tanker Regulations.

3. The light Ship figures indicated on Plate 1 were computed for vessels not provided with a Meccano deck, therefore, on T2-SE-A1 tankers, this figure should be

increased 149 tons and in T2-SE-A2 tankers, it should be increased 91 tons. This tonnage figure is multiplied by the Light Ship Longitudinal Center of Bupyancy indicated in the upper section of Plate 1; ie. Swan Island ships 215.0 feet Marinships 213.6 feet.

4. The total of column (E) must equal the displacement tonnage of the vessel at the draft it is desired to load. In this example, the sailing draft is to be 30' 9½". The displacement tonnage of this draft is 22.380 tons. This cargo being of an extremely light nature, the only tanks that will not be filled to near capacity are #5 wings. Therefore, fill in the capacities of tanks #1 and #9 in columns (D) and (C) and total column (E), this gives a difference of 132 tons which is the amount required in #5 wing tanks to fill the ship to her required displacement tonnage.

5. Total up all Moments of Weight in column (G). The total Moments of Weight is compared with the Total Moments of Displacement obtained by multiplying the displacement tonnage 22,380 by the Longitudinal Center of Buoyancy 253.1 obtained from Plate 2. The Lonitudinal Center of Buoyancy is represented on the top scale of Plate 2 (designated C.B. Forward of A.P. 1/2 = 1 foot) at the point where a vertical line drawn from a point on the L.C.B. curve at 30' 9½" draft intersects the top scale. The difference between the Total Moments of Weight and the total Moments of Displacement is called the Total Moments of Trim and must be divided by the Moments to Trim 1". Moments to Trim 1" Moments of Trim 1" is also obtained from Plate 2 and is measured on the third scale at the top of the plate (designated Moment to Change Trim 1" = 40 tons feet). The difference thus obtained must be divided by two and applied to the mean loaded draft of 30' 9½" forward and aft to give the computed trim.

6. When Moments of Weight are greater than the Moments of Displacement, the vessel trims by the head. This is readily apparent if you stop to consider the rapidity with which Moments of Weight increase as weights are moved forward. In this example, the total difference of Moments is 19,849 which represents a stern trim of 9½" because the Moments of Weight are less than the Moments of Displacement. However if 70 tons was moved from #9 tank to #1 tank, a distance of 280.1 feet, the vessel would trim on an even keel and any additional weight would increase the Total Moments of Weight above the Total Moments of Displacement which would indicate that the vessel will trim by the head.

METHOD OF COMPUTING INCREASED DRAFT WHEN VESSEL IS LOADING IN BRACKISH WATER:

Just prior to completion of the loading, a sample of the water is taken at the dock where the vessel is loading by dropping a bucket to a depth of approximately 20 feet below the surface and then withdrawn to obtain a cross-section sample of the water below the surface, which cross-section is more indicative of the average water density than would be the case of the sample were taken only on top where the fresh water tends to flow. This sample is tested with a hydrometer and found to have a specific gravity of 1.004. From Plate 1 it will be noted that the fresh water allowance is 8¼". On Plate 3, opposite the fresh water allowance of 8¼" and directly below the tabulated specific gravity of 1.004, is the brackish water correction of 6.98" applicable to this vessel under these conditions.

Since the water is nearly fresh, it follows that the vessel's draft must be approximately 7" greater than would be the case if the water were salt with a specific gravity of 1.026, therefore, the observed Mean draft at the completion of loading should be 30' 9½" plus 7" or 31' 4½". This correction is necessary to obtain the full deadweight of the vessel, which upon entering the ocean will rise to the Mean Draft of 30'9½".

The following are a series of loading problems which have been worked out to indicate representative loadings under various conditions:

T2-SE-A1 TANKERS

FULL CARGO NAVY FUEL OIL LOADING SAN PEDRO FOR DISCHARGING MILNE BAY, NEW GUINEA, SAILING DRAFT, ASSIGNED TROPICAL 30' 9½" WATER ABOARD ON SAILING FOR ROUND VOYAGE

A TANK	B PRODUCT	C BARRELS	D TONS	E CTR.GVTY	F MOMENTS
Fore Peak	Water		300	476.5	142.950
Cargo Hold	Pkg. Lube Oil	900	180	445.2	80.136
Center 2	Bulk cargo	9000	1335	393.4	525.189
" " 3	97.300 Bbls	9000	1335	357.4	477.129
" " 4	Navy Fuel Oil	9000	1335	320.9	428.402
" " 5	17.5° API	9000	1335	284.4	379.674
" " 6	(6.744 B/T)	9000	1335	247.9	330.947
" " 7		9000	1335	211.4	282.219
" " 8		9000	1335	174.9	233.492
" " 9		8800	1305	138.6	180.873
Side 1		MT		418.7	
" 2		1000	147	393.4	57.830
" 3		MT		357.4	
" 4		7800	1156	320.9	370/960
" 5		MT		284.4	
" 6		7800	1156	247.9	286.572
" 7		MT		211.4	
" 8		7700	1142	174.9	199.736
" 9		1200	177	138.6	24.532
Wings	Bunkers	4900	765	100.5	76.883
Fore Deep	Bunkers	4700	735	445.2	327.222
A.C. D.	Water				
Gravity	Water		25	22.8	570
Distilled	Water		35	31.1	1.089
Fr 11-27	Water		40	43.0	1.720
Fr 11-24	Water		30	39.4	1.182
Fr 27-44	Water		150	82.2	12.330
A.P.	Water		50	9.7	485
)O(	Water		70	302.6	21.182
Stores			75	211.4	15.855
Ammunition			25	247.9	6.198
Lt. Ship			5472	215.0	1.176.480
Draft and Trim			22.380		5.641.837

22.380 X 253.2 5.666.616

Moments 24.779

Moments to Alter Trim 2.065=11.9'

Stern Trim

Fwd	Aft
30' 9½"	30' 9½"
6	6
30' 03½"	30' 03½"

T2 TANKERS

LOADING SAN FRANCISCO BAY AREA FULL CARGO AVIATION GASOLINE AND CASES ON DECK FOR DISCHARGE IN MIDDLE EAST AREA * sailing draft 30' 9½" (TROPICAL)

TANK	PRODUCT	OUTAGE	BARRELS	TONS	CTR.GVTY.	MOM.WEIGHT
Center 2	129,368	4' 6"	9000	1017	393.4	400.088
" 3	Bbls. 100	4' 6"	9000	1017	357.4	363.476
" 4	Octane @	4' 6"	9000	1017	320.9	326.355
" 5	64° API or	4' 6"	9000	1017	284.4	289.235
" 6	8.852 B/T	4' 6"	9000	1017	247.9	252.114
" 7		4' 6"	9000	1017	211.4	214.994
" 8		4' 6"	9000	1017	174.9	177.873
" 9		4' 6"	8800	994	138.6	137.768
Side 1		4' 6"	4800	542	418.7	226.935
" 2		4' 6"	6000	678	393.4	266.725
" 3		5' 0"	7500	847	357.4	302.718
" 4		5' 0"	7800	881	320.9	282.713
" 5		37' 0"	1168	132	284.4	37,541
" 6		5' 0 "	7800	881	247.9	218,400
" 7		5' 0"	7800	881	211.4	186.243
" 8		5' 0"	7700	870	174.9	152.163
" 9		5' 0"	7000	790	138.6	109.494
Aft Deck Cases				115	202.0	23.230
Fore Deck Cases				60	365.6	21.936
Wings	Bunkers		4800	750	100.5	75.375
Fore Deep Bunkers			4600	718	445.2	319.654
A.C.D.	Fresh Water			100	118.4	11.840
Gvty.	Fresh Water			25	22.8	.570
Distilled	Fresh Water			35	31.1	1.089
Fr 11-27	Fresh Water			40	43.0	1.720
Dr 11-24	Fresh Water			30	39.4	1.182
Fr 27-44	Fresh Water			150	82.2	12.330
AP	Fresh Water			50	9.7	485
Midship	Fresh Water			70	302.6	21.182
Stores				125	211.4	26.425
Ammunition				25	247.9	6.198
Lt. Ship				5427	215.0	1.176.480
						5,644.531
				22.380	x 253.1	5.664.378
						19.897
						2.065
						-9.6" by Ster

Draft amdTrim

Fwd	Aft
30' 9½"	30' 9½"
5	5
30' 4½"	31' 2½"

T2-LOADING ON PACIFIC COAST FOR DISCHARGE IN HAWAIIAN ISLANDS
loaded Draft to be 30' 9½" (22.380 Tons Displacement)

34.000 Shell 2nd Structure 60.0° API (8.67 B/T)
99.705 100 Octane 64.0° API (8,852 B/T)

100 TONS DECK LOAD

TANK	PRODUCT	CUTAGE	BARRELS	TONS	CTR.GVTY.	MOM. WEIG.
Center 2	100 Octane	4' 6"	9000	1017	393.4	400.088
" 3	" "	4' 6"	9000	1017	357.4	363.476
" 4	" "	4' 6"	9000	1017	320.9	326.355
" 5	Shell 2nd St.	4' 0"	9100	1050	284.4	298.620
" 6	" " "	4' 0"	9100	1050	247.9	260.295
" 7	100 Octane	4' 6"	9000	1017	211.4	214.994
" 8	" "	4' 6"	9000	1017	174.9	177.873
" 9	" "	4' 6"	9000	1017	138.6	137.768
Side 1	" "	4' 6"	4800	542	418.7	226.935
" 2	" "	4' 6"	6000	678	393.4	266.725
" 3	" "	5' 0"	7500	847	357.4	302.718
" 4	" "	12' 0"	6355	718	320.9	230.406
" 5	Shell 2nd St.	4' 6"	7900	911	284.4	259.088
" 6	" " "	4' 6"	7900	911	247.9	225.837
" 7	100 Octane	12' 0"	6350	717	211.4	151.574
" 8	" "	5' 0"	7700	870	174.9	152.163
" 9	" "	5' 0"	7000	790	138.6	109.494
Ate Deck				65	202.0	13.130
Fore Deck				35	365.6	12.796
Wings	Bunkers		4800	750	100.5	75.375
Fore Deep	"		2700	422	445.2	187.874
Gvty.	Fresh Water			15	22.8	342
Distilled	" "			25	31.0	775
Fr 11-27	" "			30	43.0	1.290
Fr 11-24	" "			20	39.4	788
Fr 27-44	" "			100	82.2	8.220
A.P.	" "			40	9.7	388
Midship	" "			70	302.6	21.182
Stores				125	211.4	26.425
Ammunition				25	247.9	6.198
Lt. Ship				5472	215.0	1.176.480
						5.635.672
						5.664.378
						28.706
						2.065

Draft and Trim

-14" by
-Stern

Fwd	Aft
30' - 9½"	30' - 9½"
7	7
30' 02½"	31' 04½"

T2-SE-A1 TANKERS
LOADING FULL CARGO AVIATION GASOLINE U. S. GULF
FOR MADRAS INDIA SAILING DRAFTS GULF 30' 9½"
PANAMA 31' 5¼", HOBART 30' 2", FREMANTLE 30' 9½"

LEAVING BAYTOWN, TEXAS

A	B	C	D	E	F	G
TANK	PRODUCT	OUTAGE	BARRELS	TONS	CRT. GVTY.	MOM. WEIG.
Center 2	134.750 Bbls.	4' 6"	9000	1017	393.4	400.088
" 3	100 Octane		9000	1017	357.4	363.476
" 4	Gasoline 64.0		9000	1017	320.9	326.355
" 5	API - 8.852		9000	1017	284.4	289.235
" 6	B/T Loading		9000	1017	247.9	252.114
" 7	Temperarure		9000	1017	211.4	214.994
" 8	60° F.		9000	1017	174.9	177.873
" 9			8800	994	138.6	137.768
Side 1			4800	542	418.7	226.935
" 2			6000	678	393.4	266.725
" 3			7500	847	357.4	302.718
" 4			7800	881	320.9	282.713
" 5			6550	740	284.4	210.456
" 6			7800	881	247.9	218.400
" 7			7800	881	211.4	186.243
" 8			7700	870	174.9	152.163
" 9			7000	790	138.6	109.494
Aft Deck	Cases			100	202.0	20.200
Fore Deck	Cases			50	365.6	18.280
Wings	Bunkers		4000	618	100.5	62.109
Fore Deep	Bunkers		2300	367	445.2	163.388
ACD	Fresh Water					
Gravity				25	22.8	570
Distissed				35	31.1	1.089
Fr 11-27				40	43.0	1.720
Fr 11-24				30	39.4	1.182
Fr 27-44				150	82.2	12.330
AP				50	9.7	485
)o(				70	302.6	21.182
Stores				125	211.4	26.425
Ammunition				25	247.9	6.198
Lt. Ship				5472	215.0	1.176:480
						5,629.388
Draft and Trim				22.380	X 253.1	5.644.378
						34.990
						2.065
					= 16.9"	
					by Stern	

Fwd	Aft
30' 9½"	30' 9½"
8½"	8½"
30' 01"	31' 06"

T2-SE-A1 TANKERS
SAILING ON TROPICAL FRESH WATER DRAFT
31' 5 3/4" (DISP. 22.938) WITH BUNKER
TANKS FULL. LEAVING BALBOA, C.Z.

TANK	PRODUCT	OUTAGE	BARRELS	TONS	CTR.GVTY.	MOM.WE.
Center 2		4' 6"	9000	1017	393.4	400.088
" 3		4' 6"	9000	1017	357.4	363.476
" 4		4' 6"	9000	1017	320.9	326.355
" 5		4' 6"	9000	1017	284.4	289.235
" 6		4' 6"	9000	1017	247.9	252.114
" 7		4' 6"	9000	1017	211.4	214.994
" 8		4' 6"	9000	1017	174.9	177.873
" 9		4' 6"	8800	994	138.6	137.768
Side 1		4' 6"	4800	542	418.7	226.935
" 2		4' 6"	6000	678	393.4	266.724
" 3		5' 0"	7500	847	357.4	302.718
" 4		5' 0"	7800	881	320.9	282.713
" 5		11' 0"	6550	740	284.4	210.456
" 6		5' 0"	7800	881	247.9	218.400
" 7		5' 0"	7800	881	211.4	186.243
" 8		5' 0"	7700	870	174.9	152.163
" 9		5' 0"	7000	790	138.6	109.494
Aft Deck	Cases			100	202.0	20.200
Fore Dedk	Cases			50	365.6	18.280
				15.373		
Wings	Bunkers		4800	750	100.5	75.375
Fore Deep	Bunkers		4600	718	445.2	319.654
A.C.D.	Fresh Water			75	118.4	8.880
Gvty.	Fresh Water			25	22.8	570
Distilled	Fresh Water			35	31.1	1.089
Fr 11-27	Fresh Water			40	43.0	1.720
Fr 11-24	Fresh Water			30	39.4	1.182
Fr 27-44	Fresh Water			150	82.2	12.330
AP	Fresh Water			50	9.7	485
)O(	Fresh Water			70	302.6	21.182
Stores				125	211.4	26.425
Ammunition				25	247.9	6.198
Lt. Ship				5472	215.0	1.176.480
						5.807.800
Draft and Trim				22.938 X	253.1	5.805.608
Fwd	Aft					2.192
31' 5 3/4"	31' 5 3/4"					2.065=1
1/2"	1/2"					by head
31' 6¼"	31' 5¼"					

CAPACITIES TANKS 98% FULL

CARGO	BARRELS (42 GALS)	C.G. FROM A.P.	TONS TO TRIM 1"
CNTR. TANK 2	9137	393.4	14.5F
" " 3	9145	357.4	19.5F
" " 4	9144	320.9	30.0F
" " 5	9134	284.4	65.4F
" " 6	9139	247.9	373.2A
" " 7	9131	211.4	48.4A
" " 8	9134	174.9	25.9A
" " 9	8986	138.6	17.7A
CNTR. TK. TOTALS	72950		
SIDE TANK 1P$S	4976	418.7	12.3F
" " 2 "	6101	393.4	14.5F
" " 3 "	7640	357.4	19.5F
" " 4 "	7910	320.9	30.0F
" " 5 "	7934	284.4	65.4F
" " 6 "	7934	247.9	373.2F
" " 7 "	7929	211.4	48.4A
" " 8 "	7826	174.9	25.9A
" " 9 "	7136	138.6	17.7A
SIDE TK. TOTALS	65386		
TOTAL CARGO	138336		

TANKS [illegible] FULL

FUEL	BARRELS (42 GALS)	C G FROM A.P	TONS TO TRIM 1"
SIDE TKS. P$S AFT	4895	100.5	13.3A
DEEP TKS. 1$S FOR'D	4646	445.2	10.6F
TOTAL FUEL	9541		

FRESH WATER	U.S. GALLONS	TONS (2240 LBS)	C G FROM A.P.
GRAVITY TANK-AFT	7677	28.6	22.8
GRAVITY TANKS ~~3C~~ P$S	18977	70.7	302.6
DISTILLED WATER	9770	36.4	31.1
D.B. TNK FR 11-27 P	11113	41.4	43.0
" " " 11-24 S	8428	31.4	39.4
27-44 P	20695	77.1	82.2
27-44 S	21339	79.5	82.2
AFT PEAK	14655	54.6	9.7
TOTAL FRESH WATER	112654	419.7	

SALT WATER	Cubic Feet	TONS. (2240 LBS)	C.G. From A.P.
FORE PEAK	10997	314.2	476.5
COFFERDAM 73-75 P$S	4652	132.9	427.9
COFFERDAM FR 46-47 P$S	3997	114.2	118.4
Total Salt Water	19646	561.3	

DRY CARGO HOLD -- 15,203 CU.FT.

MACHINERY

T.2.SE.A1 TYPE	T.2.SE.A2 TYPE
G.E OR WESTINGHOUSE	GENERAL ELECTRIC
TUBO-ELECTRIC DRIVE	TURBO-ELECTRIC DRIVE
MAIN-TURBO-GEN. 5400 KW.	MAIN-TURBO-GEN. 6890 KW.
2500 V.A.C., 3720 R.P.M.	3500 V.A.C. 3600 R.P.M.
PROPULSION MOTOR	PROPULSION MOTOR
6000 SHP. @ 90 R.P.M.	9000 SHP. @ 103 R.P.M.
2 WATER TUBE BOILERS	2 WATER TUBE BOILERS
450# G. 725° F.	600# G. 825° F.

PARTICULARS

LENGTH B.P.		503'0"
LENGTH O.A.		523'6"
BREADTH MLD.		68'0"
DEPTH MLD. U.D.		39'3"
A-1.	TONNAGE GROSS	10172 EST
	TONNAGE NET.	6126 EST
A-2.	TONNAGE GROSS	10461 EST
	TONNAGE NET.	7337 EST

		DRAFT	DISPL'MT.	FREE'BD	DEADWEIGHT INCLUDING-ARMAMT.	
LIGHT CONDITION		8' 5"	5320	30' 11 3/4	T2-SE-A1	
		8' 6 1/2	5381	30' 10 1/4		T2-SE-A2
OCEAN FREE 'BD.	ASSIGNED SUMMER	30' 2"	21880	9' 2 3/4	16560	16499
	TROPICAL	30' 9½"	22380	8' 7 1/4	17060	16999
	WINTER	29' 6½"	21380	9' 10 1/4	16060	15999
	WINTER N.A.	29' 1½"	21040	10' 3 1/4	15720	15659
	FRESH-WATER-ALLOWANCE	0' 8¼"				
Co- Free 'BD.	ASSIGNED-SUMMER	30' 11"	22485	8' 5 3/4	17165	17104
	TROPICAL	31' 6 3/4"	23000	7' 10"	17680	17619
	WINTER.	30' 3 1/4"	21960	9' 1 1/2	16640	16579
	FRESH-WATER-ALLOWANCE	0' 8 1/4"				

CARGO INFORMATION - LOADING AND DISCHARGING

In the previous material we submitted to you on this subject, we discussed the method of determining draft and trim in advance of loading through computation of the forces exerted upon the vessel as weight is placed aboard. We also discussed certain characteristics of load line limitations and steps to be taken to insure the vessel is always fully loaded but never overloaded. The following information deals with a preliminary computation to determine the amount of cargo required to load your vessel to her draft, and the problems you must consider when loading more than one product. Also the additional steps that must be taken to protect your cargo if the loading of several products occurs at more than one berth, and the vessel is scheduled to discharge at more than one berth.

As you know, the dead-weight capacity of a vessel is the number of tons that can be loaded aboard acompletely light and dry ship to put the vessel down to her loaded draft. Therefore, in determining the amount of cargo to be loaded an allowance is to be made for bunkers, water, stores, ammunition and crew, which tonnage, when added to the amount of cargo, equals the stipulated dead-weight tonnage for the zone or season in which the vessel is loading.

In working cargo computations, it is of the utmost importance that ship's officers think in terms of tons rather than barrels of cargo, and it is suggested that prior to loading, a brief computation, as indicated below, be made to arrive at the basic tonnage figure.

Assuming a T2 SE A1 type vessel, with a tropical Fresh Water dead-weight of 17,482 tons, is loading in San Pedro on a voyage to the Central Pacific, it is necessary to find the deductions from this dead-weight to determine the cargo capacity.

9,500 barrels of bunkers -	1,500	tons
Fresh water -	800	tons
Stores and crew -	125	tons
Ammunition -	25	tons
Total -	2,450	
Dead-weight tonnage -	17,482	
Tonnage available for cargo -	15,032	

Starting with the basic cargo tonnage figure of 15,032 tons, we will assume that the Navy has requested us to transport 220 tons of aircraft on deck, which leaves a tonnage of 14,787 available for bulk cargo.

The basic disign of T2 Tankers is such that under war conditions it is considered essential to the war effort to carry as manu as three similar prodicts, divided up between the three basic cargo handling systems, which systems are starboard or forward, and includes tanks 1. 2. 3. and 4; the center system or tanks 5 and 6, and the port or after system which consists of tanks 7, 8 and 9. The definition of a system is taken to mean the cargo piping, both suction and discharge and also the piping in the pumproom and the pump which may be operated seperately.

It is not considered good practive to load tanks beyohd 98% of their capacity which is ,roughly speaking, to an outage of 4' 3" from the ullage plug. On this basis the starboard or forward system has a volumetric capacity of 53,989 barrels; the central system 34,133 barrels; and the port or after system 50,106, giving a total volumetric capacity of 138,000 barrels, or for easy reference 54,000 barrels, 34,000 barrels and 50,000 barrels respectively for a total of 138,000 barrels. The three systems are, as you know, connected through pipe lines in No. 5 and No. 7 tanks, as well as in the pumproom. These pipe lines are so arranged that double block valves may be closed in No. 5 tank to separate the center system from the forward or starboard system, and another set of double block valves are in No. 7 tank to separate the port or after system from the center system.

In addition to these sets of double block valves in tanks 5 and 7, there are other sets of double block valves and spectacle flanges in the pumproom between the systems on both the suction and discharge piping. Provided that both block valves of either of the two sets which separate any two systems in the pumproom are proved tight, it is the usual practice when carrying different grades of gasolines, or different grades of gas oils, or different grades of fuel oils to rely only on these double valves as being adequate for protection against cargo contamination

If gasoline is carried in one system and gas oil, or other very dissimilar product is carried in the adjacent system, safe practice calls for swinging the spectacle blanks closed between the systems on both the suction and discharge lines. There are also spectacle flanges on the discharge risers midships which are to be so set that complete cargo separation is insured in the respective systems in any case where more than one product is loaded.

Prior to loading a cargo, consideration must be given to the facilities which will be employed at the loading berth or berths and the sequence with which the cargo is to be discharged. It often occurs, particularly in carrying cargoes for the account of the U. S. Navy, that Masters will be requested to load approximately 50,000 barrels of diesel oil and the balance of the cargo in motor or aviation gasoline. We do not consider this method of loading to be good practice and at any time you are requested to load in this manner, notice should be filed with the person issuing such instructions that there is liability of cargo contamination, particularly in the T2 type vessels which are provided with only single suction valves on the loading and discharging lines, as well as on the stripping line. If, after such notice has been filed, the organization controlling the cargo insists on loading two dissimilar products, it is considered best to put the diesel oil in tanks 5 and 6, or tanks 7, 8 and 9, and gasoline in the remaining tanks.

Because of the prevalence of loading where the diesel oil is carried in tanks 7, 8 and 9, we have worked out a series of trim problems, copies of which are attached to indicate procedure you should follow. From these problems you will note that the greatest quantity of diesel oil it is possible to load and maintain a satisfactory trim is approximately 46,500 barrels, or 6,200 tons. This leaves sufficient space to load approximately 76,300 barrels, or 8,612 tons of avation gasoline and 220 tons of deck cargo. In a loading of this nature, because of the weight differential between diesel oil and aviation gasoline, you will find it necessary to leave your diesel oil outage in No. 9 wing tanks. As a matter of good practice, you are at all times, when possible, to leave an outage in No. 5 wing tanks for the purpose of reducing the sag in your vessel.

In the case of the cargo under discussion, if you leave No. 5 wing tanks compleltely empty the volumetric capacity of the ship will still allow an additional outage of approximately 9,000 barrels, which outage is to be left in wing tanks 1 and 2, as indicated in the attached trim problem.

If the cargo under discussion is loaded at one berth it becomes a relatively simple problem to trim the vessel prior to sailing by the simple expendient of finishing loading these products which go in the forward tanks and aft tanks last, which allows the vessel to be trimmed as desired.

If on the other hand, it becomes necessary to load diesel oil at one terminal, the gasoline at another terminal, you should elect to load the diesel oil first; but prior to loading into tanks 7, 8 and 9, tank No. 2 should be ballasted full in the center and wing compartments, which gives a total of approximately 15, 000 barrels ballast aboard. Upon conclusion of loading the diesel oil, your vessel should trim with approximately a 16' drag, or you should have a forward draft of 15' and adraft aft of 31' which condition will allow you to move from one terminal to another and with very little likelihood of injuring the vessel through touching the bottom at the loading berth or during the shift. Upon arrival at the gasoline loading berth, it is then necessary to load gasoline in the remaining forward compartments in such quantity that when the ballast in tank 2 is discharged there will be sufficient stern trim to allow you to strip the tanks dry and yet maintain a safe draft aft, so that your stern frame will not be injured. This may be accomplished by loading tanks 6, 5, 4 and 3, and some into No. 1, if desired. The ballast is then discharged and the remaining cargo required loaded in tank 2 as necessary to bring the vessel down to draft.

In this particular loading, we will assume the deck cargo is to be loaded last. Therefore, you must allow 3 1/4" draft upon completion of the bulk cargo for the 220 tons of deck cargo. In this regard we would like to point out that a deck cargo, in any tonnage that is feasible to load, will not, if evenly distributed about the meccano deck, materially change the trim of the vessel.

When more than one commodity is loaded in the ship's tanks, consideration must be given to the characteristics of the products being loaded in determining where they are to be placed in the vessel. It is unnecessary to point out to you that every precaution possible must be taken to avoid contamination of one product by another product. However, some products are more susceptible to contamination than others.

An example of a very serious type of contamination is one in which gasoline becomes mixed with kerosene, stove oil, or diesel oil. Gasoline of any quality is of a rapid exploding characteristic. Therefore, if it is mixed with any of the three products mentioned, its tendency is to raise the flash point of the kerosene, stove oil or diesel oil. These three products are manufactured primarily for illuminating and heating, and in the case of diesel oil, for use in internal combustion engines. Home lamps, stoves and furnaces are designed and approved by Fire Underwriters for a product of a certain flash point normally in the vicinity of 150° F. or slightly lower. Only a small quantity of gasoline needs to be introduced into these products to lower the flash point sufficiently below those points to make them extremely dangerous for home or internal combustion use. On the other hand, if kerosene, stove oil or diesel oil are allowed to contaminate gasoline the result is a reduction in the octane rating of the gasoline. It is obvious that any reduction in the power of gasoline, particularly aviation gasoline, is highly dangerous to personnel in the war zones.

The danger of contaminating two different grades of gasoline is not as great as the danger of contamination between dissimilar products. However, you must bear in mind that each grade of any petroleum product is manufactured for a specific purpose and its characteristic must not be changed if it is to be used for the purpose it was originally designed.

since the mishap is not usually discovered or does not occur until the vessel has arrived at the discharge port, which necessitates a return of the contaminated products to the original loading port where they must be re-refined and again transported to their original destination.

One of the most important phases of a Tanker Officer's work is that in connection with cargo handling, and each officer aboard a vessel should be thoroughly familiar with all phases of this very important subject. The basic rules to maintain complete separation of products are:

1. In a T2 type vessel every effort should be made to load not more than three similar products, and in such quantities that each separate cargo handling system will be used solely for one product.

2. When more than one product is loaded, complete separation of the various cargo handling systems must be maintained by closing and lashing of valves between products and swinging of spectacle flanges to the closed position.

3. Extreme care must be exercised to assure that all valves on the stripping line are kept lashed closed at all times, except when the steam stripping pump is actually in operation stripping a specific tank, at which time only the valves on the tank being stripped are to be unlashed.

4. When loading, the most direct pipe line into the tanks should be used; i.e., if possible, tanks should be loaded through the drop lines in No. 2, 5 or 7 tanks, rather than through the pumproom since this method of loading does not fill all the pipe line in the pumproom.

5. When dissimilar products are loaded in adjacent tanks, every effort should be made to prevent filling a tank on one side of a bulkhead to a greater height than the next tank. This method of loading tanks to similar outages reduces the tendency of one product to leak through faulty bulkheads or leaky valves and contaminate the product in the adjacent compartment.

6. The basic rule in stowing cargoes aboard a tanker is, that cargo which will be injured the most through contamination, such as kerosene, stove and diesel oils, should be stowed closest to the pumproom and discharged first, since this method of stowage allows such a product to be discharged with the master valves between it and the gasolines to be closed.

7. Before loading, it should be dtermined what the discharge sequence will be or, if this is not possible, cargo should be so stowed that if it becomes necessary to discharge

all of any one product at the first discharge port, the vessel will remain in a seaworthy trim to proceed to the second discharge terminal.

8. When more than one product is loaded, it should be determined prior to the loading that all steam smothering line valves are closed. Serious contaminations have occurred by leaving these lines open, which allows a small quantity of oil to pass from compartment to compartment each time the vessel rises and falls in the seaway.

9. After completion of loading, all vent relief valves should be checked to insure that they too are closed. In addition to preventing an actual flow of cargo from tank to tank, these valves reduce the tendency of volatile products to evaporate.

10. Prior to loading or discharging, valves and pipe lines should be checked personally by the Chief Officer and one other mate to insure that no oversight has occurred in lining up the vessel. Such oversights can and have resulted in serious contaminations. A valve which is intended to remain closed during the discharge of another product should always be lashed in that position to insure against being opened hastily in event of mistake.

11. Particular attention must be given to the three angle stop valves on the sea suction crossover line in the pumproom. A study of these three valves will show that they afford two valve protection between systems on the suction piping only while they are closed. These valves should always be checked to see that they are lashed closed prior to start of loading or discharging cargo. Their primary function is to give access to the sea when taking on ballast and are not to be used for cargo handling valves.

T2- LOADING AT SAN PEDRO FOR DISCHARGE IN PACIFIC AREA
Loaded Draft to be 31' 5 3/4" (22,933 Tons Displacement)

76,300 Barrels or 8,670 Tons Aviation Gasoline (8.8 B/T)
46,575 Barrels or 6,120 Tons Diesel Oil (7.6 B/T)

220 Tons Deck Cargo

TANK		OUTAGE	PRODUCT	BARRELS	TONS	CTR. GVTY.	MOM. WEIGHT
Center	2	4' 6"	Aviation Gas	9000	1023	393.4	402,448
"	3	4' 6"	" "	9000	1023	357.4	365,620
"	4	4' 6"	" "	9000	1023	320.9	328,281
"	5	4' 6"	" "	9000	1023	284.4	290,941
"	6	4' 6"	" "	9000	1023	247.9	253,602
"	7	4' 6"	Diesel Oil	9000	1184	211.4	250,298
"	8	4' 6"	" "	9000	1184	174.9	207,082
"	9	3' 8"	" "	9000	1184	138.6	164,102
Side	1	32' 3"	Aviation Gas	1168	133	418.7	55,687
"	2	4' 6"	" "	6000	682	393.4	268,299
"	3	5' 0"	" "	7500	852	357.4	304,505
"	4	5' 0"	" "	7800	886	320.9	284,317
"	5	37' 0"	" "	1049	119	284.4	33,844
"	6	5' 0"	" "	7800	886	247.9	219,639
"	7	5' 0"	Diesel Oil	7800	1026	211.4	216,896
"	8	5' 0"	" "	7700	1013	174.9	177,174
"	9	18' 6"	" "	4075	536	138.6	74,290
Fore Deck			Deck Cargo		70	365.6	25,592
After Deck			" "		150	202.0	30,300
Wings			Bunkers		765	100.5	76,883
Fore Deep			"		735	445.2	327,222
			Water		200	Constant	* 193,348
			Stores		125	211.4	26,425
			Ammunition		25	247.9	6,198
			Lt. Ship		5463	215.0	1,174,545
					22,933		5,757,538

22,933 x 253.1 = 5,804,342

46,804 = 2,065 2'
Stern Trim

Draft and Trim

Fwd	Aft
31' 5 3/4"	31' 5 3/4"
1'	1'
30' 5 3/4"	32' 5 3/4"

* Sum of Moment Weights of all Fresh Water compartments.

TANKER REGULATIONS

Due to the inherent nature of petroleum products it is especially important that all necessary safety measures are taken by you in order to afford your crew, ship and cargo the maximum protection at all times. SAFETY FIRST should always be your first consideration.

Nothing in the following tanker regulations is to be construed as limiting the Master in establishing such additional safety precautions as he may deem advisable during emergencies, and in circumstances not covered by these regulations the Master shall use his discretion in determining the best manner in which to cope with a particular situation.

The classification of petroleum products as used throughout these regulations conform to those contained in "Tank Vessels" issued by the Bureau of Marine Inspection and Navigation and are as follows:

Grade A (Inflammable)

Any inflammable liquid having a Reid Vapor Pressure of 14 pounds or more.

Grade B (Inflammable)

Any inflammable liquid having a Reid Vapor Pressure under 14 pounds and over $8\frac{1}{2}$ pounds.

Grade C (Inflammable)

Any inflammable liquid having a Reid Vapor Pressure of $8\frac{1}{2}$ pounds or less and a flash point of 80° F. or below.

Grade D (Combustible)

Any combustible liquid having a flash point below 150°F. and above 80°F.

Grade E (Combustible)

Any combustible liquid having a flash point of 150°F. or above.

Note: When loading a combustible liquid or water ballast into tank which previously contained an inflammable liquid and which has not been gas-freed, the combustible liquid or water ballast shall be handled in the same manner as an inflammable liquid. When loading water ballast in a tank which previously contained a combustible liquid it shall be handled in the same manner as a combustible liquid.

SUPERVISION

1. During the handling of bulk or package cargo (or ballast at a wharf or terminal) at least one deck officer shall be on deck to supervise such operations. He shall be responsible for having sufficient assistance to insure that all such operations are performed with safety. During the handling of bulk cargo, he shall have at least two assistants, one to maintain a constant watch on the hose and the other to assist in handling of valves, pumps, etc. Ship's officer to assure himself that the terminal is adequately manned to properly tend terminal hose connections and control bulk cargo and ballast movements, etc. If terminal is not so manned, bulk cargo and ballast movements shall not be started, or if started shall be stopped until the condition is corrected.

2. In the event of fire on the vessel, wharf or a vessel moored thereto, the senior deck officer aboard shall assume responsibility for the protection of the ship and the ship's personnel and cooperate with terminal, municipal and harbor fire fighting authorities.

GENERAL

3. Masters and deck officers shall have an intimate operating knowledge of all cargo pumps, pipe line systems, deck machinery, cargo handling and fire fighting equipment aboard their ship.

4. Should any circumstance arise which in the opinion of ship's officer would make the handling of bulk cargo, package cargo or ballast hazardous, such cargo or ballast movements shall be stopped, and if necessary, the hose disconnected until the condition has been corrected or the ship's officer is satisfied that the danger no longer exists.

5. The handling and carriage of certain special cargoes in bulk, such as sour crudes, shall be done in accordance with special instructions which will be sent with the ship's orders.

6. Only flash-lights of approved vapor proof type in first class condition may be used aboard ship; such lights may be used at any time.

7. Safety matches only may be used aboard ship (any other type of matches or lighters are prohibited aboard ship.) The carrying of safety matches by persons engaged in the handling of bulk or package cargo is prohibited.

8. All deck valves on the main cargo and stripping pipe line system shall be painted for easy recognition as follows: (These vary in different companies. Note:-

MAIN SUCTION & FILLING VALVES	Green
MAIN BLOCK VALVES	Yellow
STRIPPING SUCTION & FILLING VALVES	Red
STRIPPING BLOCK VALVES	White
BUNKER TANK VALVES	Black

SEA SUCTIONS

9. Sea valves to cargo system shall be locked closed except when the valves are being used in the loading or discharging of ballast. Prior to the handling of bulk c argo, these valves shall be inspected by a deck officer to insure that they are locked closed. A signed entry shall be made in the log book each time the sea suctions are locked, unlocked or inspected. One key for the sea suction padlocks shall be kept by the Master, one by the Chief Engineer and one by the Chief Officer. These keys shall be kept in a safe place to prevent unauthorized persons obtaining possession of them. (War time regulations prohibit the locking of sea suctions. They may be lashed only.)

BONDING

10. Before connecting hose between the ship and wharf pipe lines for the purpose of loading or discharging inflammable liquids in bulk, the ship shall be connected to the shore pipe lines by means of an approved bonding cable. The connections are to be made fast to clean metal surfaces. This bonding cable shall remain connected to the pipe lines until all hoses have been disconnected and spillage, if any, has been removed. The bonding cable is not required at a submarine terminal.

ELECTRICAL SUPPLY CABLE

11. When using electrical current from ashore in place of ship's power, the electrical cable shall run aboard the vessel as remote as is practicable from cargo spaces. The cable shall be connected before starting cargo movements and disconnected after oil movements have stopped. The ship's engineer shall be responsible for the connecting of this cable.

SCUPPER PLUGS

12. During the loading or discharging of bulk cargo, scupper plugs shall be tightly fitted in all scupper holes on the weather deck in way of cargo tanks, except on vessels using water for deck cooling.

SMOTHERING LINES

13. Under usual circumstances the valves on the smothering system branch lines to the cargo tanks shall be left open and the master valve shall be kept closed. However, when the leaving open of the vales on the branch lines may cause a contamination of cargo by the passage of liquid or vapors between tanks or compartments, they shall be kept closed.

VAPOR COLLECTING SYSTEM

14. The vapor collecting system consists of the vapor collecting vent lines leading from the tank tops to the mast head. The vapor collecting system is to be used when handling Inflammable liquids in bulk. In handling combustible liquids in bulk the vapor collecting system is to be used to the maximum extent possible in venting these cargo tanks. However, when handling two or more products simultaneously every precaution must be taken to prevent product contamination.

TANK HATCHES AND ULLAGE HOLD COVERS

15. When the ship is not handling cargo the tank hatches and ullage hole covers shall be dogged down to avoid the escape of vapor or the entry of water (except when tanks are gas free.)

16. During the handling of bulk cargo or ballast, tank hatches and ullage hold covers shall be controlled as follows (except when loading overall - see paragraph 43):

A. When handling inflammable liquids the tank hatches shall be dogged down and the ullage hole covers closed. The vapor collecting system shall be open to the atmosphere.

B. When handling Combustible liquids the tank hatches may be left undogged and the tank may be vented through the ullage hole with the flame screen fitted. If Inflammable liquids are being handled in the ship in the same cargo shipment, the vapor collecting system vents on the tanks handling Combustible liquids shall be kept closed.

C. When handling ballast in tanks containing Inflammable liquid vapors the same rules shall apply as in paragraph 16 A.

17. Unless tanks are gas free, tank hatches and ullage hole covers shall be kept closed during the time a towboat, etc., is alongside.

18. To prevent leakage, care should be exercised that tank hatches and ullage hole covers seat properly. To avoid springing hatches and damaging packing, hatch covers should be dogged down evenly and securely, but not with extreme tightness.

19. Tools, when needed for tightening and loosening butterfly nuts on hatch covers, shall be of a non-sparking type.

CARGO HOSE CONNECTIONS AND WATCH

20. Wharf hose shall be used when available, provided the ship's officer is satisfied that it is in good condition.

21. When handling "Inflammable Liquid" in bulk, the hose connections (on both ship and dock) should be made as remote as practicable from vessel's fireroom or engine room spaces, particularly when galley and boiler fires are burning, or internal combustion engines are being operated.

22. A ship's officer shall superintend the connecting and disconnecting of cargo hose. In lifting hose with a fall or gantline, a strap shall be used in such a manner as not to cause excessive bends or kinks. When hoisting the hose with a winch on which the fall is not made fast to the drum, two men shall operate the winch; one shall operate the throttle, the other tend the line at the gypsy head. At no time shall gantlines or falls which support the hose be made fast to a moveable object such as the gypsy head, etc.

23. All bolt holes in the flanges shall be used in making hose connections. Bolts shall be set up evenly. Only one clean flexible gasket shall be used in each connection. When connecting or disconnecting a hose, all precautions shall be taken to avoid the spillage of oil; when necessary, drip pans shall be used, and the disconnected hose should be blanked with a blind flange.

24. Sufficient hose shall be used to provide for any movement in ship's position due to tidal conditions, change in draft, etc. Mats shall be used where needed to avoid hose chafing. In order to minimize kinks and bends when hose is connected, the hose shall be suspended with a bridle and otherwise secured as necessary but shall not be bent to a radius less than 12 times its diameter.

25. During loading and discharging operations, in addition to any men detailed to assist in the manipulation of cargo valves or perform other duties about deck, an able seaman shall be stationed to maintain a watch on the cargo hose. The watchman shall be properly instructed in the measures to be taken in an emergency, the care of hose to avoid kinking, chafing, excessive pressures, etc.

26. When discharging bulk cargo or ballast, hose pressure shall not exceed 100 lbs. per sq. in. and excessive pulsations shall not be permitted.

27. When loading bulk cargo, to avoid damaging strainer boxes and other low pressure fittings, the pressure on the pipe line suction system shall not exceed 50 lbs. per sq. in.

28. Compressed air shall not be used to displace "Inflammable Liquids" in bulk from cargo hose or pipe lines.

29. In case of a hose failure (either ship or wharf hose) the Master shall submit a written report to the management giving full particulars.

SEPARATION OF OIL IN SHIP'S TANKS

30. The separation in ship's tanks of two or more products which might contaminate each other by a mixture of either liquid or vapor must be considered in the light of the practicable possibilities of the ship for each particular cargo. The difference in the specifications of products, make difficult the establishment of hard and fast rules to govern the separation of products. However, the following is given as a general guide in this regard:

A. Ship's officer shall assure himself that tank bulkheads and piping systems are in suitable condition.

B. Valves in smothering lines shall be controlled as indicated in paragraph No. 13.

C. Consistent with other provisions of this regulation, bulk cargo may be loaded while other cargo is being discharged from other tanks, provided separate oil piping systems are used or oil pipe lines to tanks being used for these purposes are separated by blind flanges.

D. Consistent with suggested tank layout and other instructions given in ship's orders, insofar as practicable different products shall be handled in independent piping systems.

INSPECTION OF CARGO TANKS BEFORE LOADING

31. Before the loading of bulk cargo is started, the ship's officer (and terminal executive or an oil inspector, if concerned) shall inspect all cargo tanks and determine that such tanks are in condition to receive cargo.

METHOD OF SIGNALING

32. Prior to the loading or discharging of bulk cargo (or ballast at a terminal), the ship's officer and terminal executive shall discuss and agree upon the method of signaling to be employed in controlling bulk cargo or ballast movements. The most effective means available at each terminal are to be used, having in mind a day and night signal, an emergency stop signal, etc. No movement of bulk cargo or ballast is to be started or continued unless the exchange of signals is clearly understood.

MAXIMUM CARGO TEMPERATURE

33. Bulk cargo shall not be loaded at a temperature in excess of 140° Fahrenheit (in ship's tanks) except with the approval of the management. Instructions covering the heating of cargo prior to discharging will be given in the ship's orders.

ALLOWANCE FOR EXPANSION OF CARGO

34. When loading bulk cargo, proper allowance shall be made for cargo expansion resulting from an increase in temperature. The temperature of the cargo will closely approximate the sea temperature encountered.

ADVICE OF READINESS TO LOAD OR DISCHARGE

35. Procedure to be followed prior to loading and discharging of bulk cargo or ballast at a terminal:

A. Upon arrival, the ship's officer shall notify the terminal executive as to the vessel's readiness to load or discharge bulk cargo, water ballast or slop oil.

B. "Notice of Readiness", shall be used as indicated in ship's orders.

SMOKING

36. During cargo handling, smoking aboard ship shall be permitted only when boiler or galley fires or the operation of internal combustion engines are allowed and then only at such times and in such enclosed spaces as approved by the Master.

CARGO HANDLING PROHIBITED

37. The handling of bulk or package cargo is prohibited under the following conditions:

A. During severe electrical storms.

B. When there is danger of a moving ship running afoul of the vessel.

38. The handling of "Inflammable Liquid" in bulk is prohibited when fires or the operation of engines on other vessels, operation of trolley cars, locomotives or automobiles, naked or exposed lights are, or come within 200 ft. of the ship. Exception to this rule may be made when the ship's officer and terminal executive agree that no hazard exists.

PRECAUTIONS DURING CARGO HANDLING

39. During the handling of bulk or package cargo, the following precautions shall be observed:

A. Fire hose with nozzles attached shall be connected up to the fire hydrants at each end of the vessel and be arranged on deck ready for use. The hose shall be of sufficient length so that all parts of the vessel may be reached. When alongside a wharf and the ship's power is down, the ship's fire lines shall be connected and open to the wharf fire lines.

B. Foamite equipment shall be connected up on deck and ready for instant use with an emergency supply of dry powder near at hand.

C. During hours of darkness ship's officer shall assure himself there is adequate illumination aboard ship, particularly in way of cargo hose, connections and deck. The surface of the water surrounding the vessel shall be inspected as necessary to assure that oil is not escaping overboard.

D. The following signals shall be displayed in a conspicuous place.

By day, at anchor or at a terminal - a red flag
By Night, at a terminal - a red light visible all around the horizon.

E. The use of approved portable electrical appliances (heaters, toasters, radios, non-gas tight electrical motors, etc.) shall only be allowed when and where smoking is permitted. (In war time, portable electric equipment may be used only after inspection and approval by Chief Engineer and Master.)

F. The use of portable lighting equipment (flood lights, hand portables, etc.) shall not be allowed on deck in way of cargo hatches or in spaces subject to vapor accumulation.

G. When any person is required to enter the lower pumproom during the handling of bulk cargo, one man shall maintain a watch at the pumproom door.

40. During the handling of "Inflammable Liquid" in bulk, the following additional precautions shall be observed:

A. When loading "Inflammable Liquid" in bulk at a wharf, boiler and galley range fires and the operation of internal combustion or electrical engines are prohibited. This rule is not applicable when loading ballast, or when loading at a wharf or submarine terminal located at an open roadstead, or where port regulations make it mandatory to maintain ship's power.

B. When discharging "Inflammable Liquid" in bulk, galley or boiler fires and the operation of internal combustion and electrical engines are permitted, except when prohibited by port or terminal regulations (in which cases shore power will be provided for discharging).

C. The ventilators shall be properly trimmed and bulkhead doors, portholes, skylights and such other openings leading from the weather deck to quarters, engine room, fireroom or galley shall be closed as required to prevent vapors from reaching enclosed spaces and a possible source of ignition.

D. No vessel shall be moored alongside the vessel handling "Inflammable Liquids" in bulk, nor shall the vessel discharge or load such products in bulk across the deck of another vessel. Exception: "Inflammable Liquids" in bulk may be discharged into, but not loaded from, a barge (or lighter) moored alongside. When discharging into such a barge, care must be taken that the barge is moored as remote as practicable from vessel's fireroom spaces, galley, etc. Care must be taken that there are no fires or operation of engines on the barge, and that rules prohibiting smoking and other applicable rules are observed.

E. Wireless transmission or any electrical repair work on a live system liable to involve a short circuit is prohibited.

START OF LOADING AND DISCHARGING OPERATIONS

41. Prior to the handling of bulk cargo or ballast, the ship's officer shall make sure that the ship's valves are properly set to prevent contamination or loss of bulk cargo. Particular care shall be taken that the overboard discharge and the sea suction valves are properly set.

42. No loading or discharging of bulk cargo shall be started until there is a complete understanding between the ship's officer and the terminal executive as to the amount and grades of cargo to be handled. The cargo movements shall be started slowly and cargo system shall be watched for excessive pressures and leaks. An inspection of the tanks from out or into which the cargo is being pumped shall be made to determine that the proper movement of cargo is resulting. After the ship's officer has satisfied himself that everything is in good order, he shall notify the terminal executive and the rate of cargo movement shall be increased to a safe maximum. As many tanks may be loaded at the same time as the ship's officer shall deem safe.

LOADING OVERALL

43. Only "Grade E liquids" in bulk (having a flash point of 150° F. or above) may be loaded overall. The tank top shall be kept open only sufficiently to admit the hose. The end of the hose must be securely lashed to prevent movement.

TOPPING OFF TANKS

44. In topping off tanks, every precaution shall be taken to prevent an overflow, reducing the flow rate of oil or number of tanks being loaded as necessary. Close communication shall be maintained with terminal personnel. Shore personnel shall be given sufficient notice to insure proper control of terminal valves, pumps, etc.

SHUTTING DOWN CARGO MOVEMENTS

45. When shutting down loading, shore valves shall be closed first; when shutting down discharging, ship valves shall be closed first.

BALLAST

46. Ballast shall not be handled while handling bulk cargo except when it is impractical to do otherwise, and then only after the procedure has been discussed by the ship's officer and terminal executive (and an oil inspector, if concerned) and all precautions have been taken to prevent contamination and loss.

47. Tank bottoms, ballast water, or tank washings containing traces of any oils, including gasoline, shall not be discharged overboard while a vessel is moored at a wharf, or terminal, or at anchor, or while underway in areas where the presence of such oils on the water may create a dangerous condition. Such oil, or slops, shall be discharged into terminal ballast line, or, as when washing tanks at anchor, accumulated in one or as few ship's tanks as practicable and subsequently discharged ashore. The above does not prevent the draining or pumping of clean water out of a tank containing accumulations of tank washings or ballast nor, consistent with oil pollution regulations, does it prohibit the discharging of tank washings overboard while the vessel is under way at sea, or in areas where the presence of such slop oil would not create a dangerous condition. While moored at a wharf or terminal, no ballast water shall be pumped overboard without first notifying the terminal executive.

POLLUTION OF NAVIGABLE WATERS

48. Except in cases of extreme emergency, no oils or oily mixtures that would be visible upon the surface of the sea shall be discharged into or upon any inland navigable waters or within a zone of 25 miles bordering the coasts of the United States and its territories. Should oil pollution be observed on the surface of water within these zones, the approximate area and position of the pollution, its source (if known) and any other facts available shall be entered in the deck log book.

OIL SPILLAGE

49. Should any oil spillage occur from any cause in connection with the handling of bulk cargo (either on ship or shore) the Master shall submit a letter to the management giving full particulars including the estimate amount of oil spilled overboard.

ONCARRIED CARGO

50. Bulk Cargo is not to be loaded into tanks containing oncarried bulk cargo until the ship's officer has discussed the procedure with the proper authorities and approval has been granted.

TESTING OF CARGO HANDLING SYSTEM AND EQUIPMENT

51. All tests referred to in paragraph 52, are to be made hydrostatically under the supervision of the Chief Engineer and the Chief Officer. It is recommended that testing be carried out on the ballast voyage. Air shall be bled from hose and pipe lines being tested so that a true hydrostatic test will result. The results of all tests shall be entered in the deck log book.

52. Bulkheads used for separating different products shall be tested as necessary to determine their suitability (with respect to tightness) for the cargo to be carried. This test may be made with either ballast or cargo. In addition, at least once each year and as near as possible to the next overhauling period, all cargo tank bulkheads shall be tested for leaks.

The following tests are to be made at intervals of six months (insofar as practicable just prior to each periodical overhauling) and when otherwise required to assure that the equipment is in good condition.

A. Pipe line suction system, strainer boxes and other low pressure fittings: 50 lbs. per sq. in.

B. Pipe line discharge system: 125 lbs. per sq. in.

C. Cargo pump relief valve (and so set): 125 lbs. per sq. in.

D. All cargo hose shall be tested at a pressure of 150 lbs. per sq. in. This pressure shall be maintained for a period of 10 minutes. If any sweating, leaking at nipples bulges or any other defects become evident the hose shall be marked condemned and removed from service. The hose shall be examined internally and if the lining appears badly frayed, or the spiral displaced the hose shall also be marked condemned and removed from service.

PUMPROOM ALARM

53. The pumproom alarm whistle when vessel so fitted shall be tested manually prior to each loading or discharging of bulk cargo.

TANK RELIEF VALVES

54. Pressure-vacuum relief valves when vessel so fitted on tank tops or in cargo tank vent lines shall be kept set to operate at 3 pounds pressure and 1-½ pounds vacuum.

GAUGING, THIEVING AND TAKING OF TEMPERATURES OF SHIP'S BULK CARGO

55. Gauging, thieving and taking of temperatures for entry on the vessel's Tank Gauges Report shall be done by the ship's officer (irrespective of others) with approved equipment. Clean equipment shall be used when taking these measurements of refined products. All measurements of cargo in ship's tanks carried out by authorized shore personnel shall be done with the approval of the ship's officer.

56. Ship's bulk cargo shall be gauged for entry on Vessel's Tank Gauges Report as follows:

A. All tanks shall be gauged before and after loading or discharging, When tank bottoms are plainly visible before loading and after discharging, a visual inspection will suffice for a gauge.

B. All gauges shall be taken to the nearest quarter of an inch.

C. An outage gauge taken manually shall show the distance from the top of the oil to the top outboard rim of the ullage hole.

D. A sounding (innage) gauge shall show the height of oil in
8 the tank and should be made to the measured depth of the tank.

57. Ship's bulk cargo shall be thieved for entry on Vessel's Tank Gauges Report as follows:

A. All kerosenes, solvents and gasolines shall be thieved.

B. Thieving of such products shall be done before and after loading and discharging when oil is in the vessel.

C. Thieving measurements shall be made to the measured depth of the tank and to the nearest quarter of an inch. The thieving rod shall be allowed to set in the oil at least three minutes.

58. The taking of temperatures of ship's bulk cargo for entry on Vessel's Tank Gauges report shall be done as follows:

A. Whenever any bulk product is loaded or discharged, sufficient temperature readings shall be taken to determine the temperature of the cargo in the various tanks.

B. The thermometer shall be lowered to one-half the depth of the oil and allowed to remain at least three minutes, it shall then be quickly withdrawn and read.

SAMPLING OF SHIP'S BULK CARGO

59. Ship's cargo shall be sampled as follows:

A. Sampling of cargo in ship's tanks carried out by authorized shore personnel shall be done with approval of the ship's officer.

B. Cargo samples shall be taken when so directed in ship's orders; also at such other times as the Master considers warranted.

C. Samples shall be obtained by lowering the sample bottle to the bottom of the tank, removing the cork and slowly drawing the bottle to the top of the oil. The ship shall be equipped with sample bottles, bottle containers, etc. Clean equipment shall be used when taking refined oil samples.

PACKAGE CARGO AND STORES

60. Ship's officer is responsible for the proper handling, stowage, care and delivery of package cargo. The use of stevedores or other shore personnel in no way relieves the ship's officer of this responsibility.

61. Winch fall, copping lifts, blocks, slings, etc., are to be overhauled periodically and maintained in good condition.

62. A clean cargo hold shall be provided for loading package cargo. When ship's crew is not available for this work, the stevedores engaged to work the cargo may be required to suitably clean the cargo hold. The deck of the hold shall be adequately covered with dunnage prior to loading package cargo.

63. Before men are permitted to enter a cargo hold to handle package cargo, the hold and other spaces having openings into the hold are to be tested with a gas indicator. Should the vapor content exceed .1, men shall not be allowed to enter until the hold and other spaces have been properly ventilated ("Safe for Men", .1 or less on the indicator.) Particular care shall be taken when the hold contains inflammable liquids in packages, or adjoining spaces contain inflammable liquids in bulk.

64. The carriage of package cargo shall be confined to the cargo hold spaces, although certain exceptions may be made by obtaining proper approval.

65. Care must be taken that electric switches, winches and lights in way of the cargo hold are vapor-proof and in good condition.

66. During the loading and discharging of package cargo, a save-all shall be stretched between ship and dock abreast of the cargo hold.

67. Package cargo and stores are not to be hoisted over a connected cargo hose.

68. During the loading of inflammable liquids in bulk only steam or air-driven winches may be used to handle package freight or stores. These winches must derive their power from a source ashore at least 200 ft. from the cargo hose and tanks into which cargo is being loaded.

69. Damaged package cargo or leaky barrels are not to be loaded. Empty barrels, before being loaded, are to be fitted with bung and a tight gasket.

70. Package cargo shall not be stowed in a cargo hold over tanks containing either inflammable liquids in bulk or their vapors.

71. Insofar as practicable, package cargo containing inflammable liquids is to be stowed in the most accessible place in the cargo hold.

72. Full barrels shall be dunnaged between each tier. Barrels shall not be stowed on cases. Cases may be stowed on barrels, provided a proper floor of dunnage has been made over the barrels.

73. All full barrels are to be stowed bung up and other containers head up.

74. Inflammable gas containers (Flamo cylinders), both full and empty, are to be stowed on end, with small end up, and no freight is to be stowed on them.

75. Package cargo shall be adequately secured to prevent movement.

76. Stores which may cause a spark hazard, if dropped, shall not be handled on the main deck in way of cargo tanks in which inflammable liquids are being handled, but may be loaded from the dock to the poop deck.

INTRODUCTION

These rules outline the general requirements of this Company for the cleaning of cargo tanks and other tanks and enclosed spaces subject to vapor or sediment accumulation aboard ship, either for change of product, repairs or drydocking, etc. (The conditions under which repairs may be made aboard ship are set forth in "Tanker Regulation No. 3 Repairs.")

GENERAL

1. At all times SAFETY shall be your first consideration.

2. Nothing in this regulation shall be construed as limiting the Master in establishing such additional safety precautions as he may deem advisable.

3. In all tank cleaning operations care must be exercised that the oil pollution regulations are not violated.

4. Gas Freeing and/or cleaning tanks at sea is to be carried out consistent with weather conditions, particularly with respect to any manual labor in tanks that might be required to complete cleaning and/or removal of sediment, scale, etc. Accumulations of residue and/or scale, etc., shall be removed from tank bottoms periodically, as opportunity affords, in order to avoid contamination of future cargo and/or difficulty in stripping tanks. It must, however, be kept in mind that washing of tank sides and internal members should be avoided unless there is a real need of this cleaning, for the removal from the interior of the tank of protective oil film tends to accelerate corrosion.

5. In order to obtain the maximum degree of safety and efficiency when necessary to gas free or clean tanks, the mechanical equipment (Butterworth machines, etc.) which is provided shall be used wherever practicable. The Butterworth machines were installed primarily to permit washing of tanks with the tank tops closed, thereby preventing the escape of oil vapors about the deck. For the information of those concerned, a booklet published by the manufacturers giving general information on the use and care of Butterworth machines, has been placed aboard all vessels having this equipment. Tanks shall ordinarily be cleared of gaseous vapor by means of windsails.

6. When cleaning tanks which have contained viscous oils, such as fuel oil, asphalt and certain heavy crudes, a short period of tank steaming immediately prior to the use of the Butterworth machines is recommended. This heating will facilitate the removal of oils adhering to the tank frames, sides, etc. In carrying out this operation, care should be taken that tanks are heated gradually and that the temperature of tanks does not become excessive.

7. In order to avoid building up undue pressure in tanks being steamed, weighted ullage hole covers shall be left unpinned and hatch cover dogs engaged. If ullage hole covers are not weighted, they shall be pinned and hatch cover dogs shall be disengaged. If equipped with a vent system the valves in vent lines shall also be opened to provide an unobstructed vent to the atmosphere.

8. Tanks shall not ordinarily be manually washed by hose from the deck unless the vapor content of such tanks is .2 or less on J-W indicator.

9. The temperature of water used in the hand-hosing of tanks shall be controlled so that it does not exceed 125°F. in the line.

DEFINITIONS

10. The term "gas-freeing" as used throughout this regulation refers to removal of vapors from tanks, pipe lines and compartments (pumproom bilges, base of cargo masts, vent pipes, heating coils, smothering lines, etc.) to render such spaces within the allowable limit of vapor concentration for the intended work, as set forth in Paragraph 13 of this regulation.

TESTING OF TANKS AND OTHER SPACES SUBJECT TO VAPOR ACCUMULATION

11. All tests for vapor concentration required by this regulation shall be made by a qualified ship's officer with the J-W Indicator. When at a terminal, ship's representative or terminal executive may, if he deems it necessary, require that such tests be verified by a qualified gas inspector or chemist from ashore. Tests for "hot work" (that is, repairs involving the use of fire or heat, such as welding, burning, riveting, heating, etc.) shall be made by both the ship's officer and a qualified gas inspector or chemist from ashore.

12. Upon the arrival of a vessel at a shipyard, and prior to commencement of repairs, alterations, drydocking, etc., in addition to previous tests made, a licensed chemist shall test all tanks and compartments and furnish to a representative of this Company, a certificate stating the condition of such spaces. Form P.T.-31, "Gas Free Certificate" (or similar form) is to be used for this purpose.

13. When describing the condition of a tank on the certificate, only the following terms are permitted to appear:

A. "Not Safe" means that vapor content of space so certified exceeds .1 (on J-W Indicator), which vapors are dangerous for both men and fire and must be removed before men can enter or work be undertaken.

B. "Safe for Men" means that vapor content of space so certified is .1 or less (on J-W Indicator.)

C. "Safe for Men and Fire" means that vapor content of space so certified is .1 or less (on J-W Indicator) and there is no oil or sediment present in such space which would produce vapors.

14. The final testing of tanks to determine their suitability for work, etc., shall be made after operation of gas exhauster or other means of ventilating tanks has been stopped.

15. If, after certification, sediment in tanks is disturbed, ballast shifted, pipe lines disconnected, or other conditions arise which would affect the vapor content, such tanks shall be inspected and passed again before any further work is undertaken.

FIRE PRECAUTIONS

16. The following precautions against fire shall be taken during tank cleaning operations:

A. Smoking shall be permitted only in enclosed spaces (quarters, etc.) as permitted by the Master. At certain terminals smoking is prohibited aboard ship during tank cleaning operations; in such circumstances ship personnel shall be governed accordingly.

B. The carrying of matches and lighters by personnel engaged in tank cleaning is prohibited.

C. Ventilators shall be properly trimmed, bulkhead doors, portholes, skylights and such other openings leading from the weather deck to the quarters and/or the engine room, fireroom or galley shall be closed as required to prevent vapors from reaching a possible source of ignition.

D. Gas Freeing of tanks is prohibited when fires or the operation of engines on other vessels, operation of trolley cars, locomotives, automobiles, naked or exposed lights come within 200 feet of the tanks being gas freed.

E. When, in the opinion of ship's officer or terminal executive, there is danger of a moving ship running afoul or coming within 200 feet of the vessel gas-freeing tanks, this tank work shall be stopped until it is agreed that the hazard has ceased to exist.

F. During tank cleaning operations if vapors are present about decks, wireless transmission is prohibited.

G. Before connecting hose between a ship and wharf pipe lines for the purpose of discharging tank washing from tanks which previously contained "Inflammable liquids" in bulk, the ship shall be properly bonded to the shore by means of an approved bonding cable.

H. The use of portable electrical appliances (heaters, toasters, radios, non-gas tight electrical motors, etc.) shall be allowed only where and when smoking is permitted. Note:-- Use of any portable equipment shall be subject to approval of Chief Engineer and Master before being used.

1. Should any circumstance occur which in the opinion of ship's officer (or terminal executive, when concerned) would make tank cleaning operations hazardous, the tank cleaning shall be discontinued until the condition has been corrected or it is agreed that the danger no longer exists.

TEMPORARY LIGHTING

17. The use of temporary lighting (portables, flashlights, etc.) in tanks and spaces subject to vapor accumulation is not permitted until such spaces have been passed as "Safe for Men" and then shall be controlled as follows:

A. Only light globes and flashlights of vapor-proof type, in first class condition, shall be used.

B. During the period portable lighting is being used, an engineer or other qualified person shall be on duty to move the lights, operate switchboards and maintain such equipment in a safe condition.

C. Care shall be taken that portable or stationary electrical distributing panels and plug fixtures are only used when remote from inflammable vapors.

D. Such lights shall be secured (but not by means of electrical cables) and unless the tank has been certified as "Safe for Men and Fire," the lights shall not be moved in or out of a compartment until first disconnected from source of electrical supply.

ENTERING OR REMAINING IN TANKS

18. The following precautions shall be taken prior to men entering tanks:

A. Tanks or other spaces subject to vapor accumulation shall be tested by a licensed officer before allowing men to enter.

B. Men shall only enter tanks or other spaces subject to vapor accumulation under the direction of a licensed officer.

C. Men shall not enter tanks or other spaces subject to vapor accumulation when the vapor content of such spaces exceeds .1 on J-W Indicator. Exception: See paragraph 18 E.

D. Fresh water tanks or other spaces which have been closed for some time are not to be entered until they have been properly ventilated to insure that they are not deficient in oxygen content. (Displacement of atmosphere in tank by at least three volumes of fresh air is recommended.)

E. Whenever it is imperative for men to enter tanks or other compartments, the vapor content of which is greater than .1 on J-W Indicator or which have not been ventilated as set forth in paragraph D above, only men fitted with properly working fresh air type gas masks and life lines and under direct supervision of a licensed deck officer may do so.

19. A. Excepting when all tanks have been certified as "Safe for Men and Fire," men in a tank shall be tended by a man stationed on deck at the hatch.

B. No less than two men shall work in a tank at one time when a man is not in attendance at the hatch.

C. The handling of "Inflammable liquids" in bulk is prohibited when men are in tanks.

D. When "Inflammable liquids" in bulk are aboard, men shall not be permitted to work in tanks if such tanks are interconnected by oil pipe lines, unless such interconnecting oil pipe lines are separated by a blind flange and valves in auxiliary lines (vapor collecting, smothering lines, etc.) are tightly closed and, if practicable, lashed in that position.

E. "Combustible liquids" in bulk or ballast shall not be handled in adjoining tanks or in tanks interconnected by oil lines (suction, stripping, or drop lines) to the tanks in which men are working unless such lines are blanked off by a blind flange and the valves on interconnecting auxiliary lines (vapor collecting, smothering lines, etc.) are tightly closed and, if practicable, lashed.

F. Butterworthing of tanks is prohibited when men are working in adjoining tanks.

G. Steaming of tanks is prohibited in adjoining tanks or in tanks interconnected by pipe lines to the tanks in which men are working unless the valves on such interconnecting pipe lines are tightly closed and, if practicable, lashed.

H. Valves and openings between tanks where men are working and spaces which contain oil vapors (the concentration of which exceeds .1 on J-W Indicator) shall be tightly closed and, if practicable, lashed in that position.

I. Men engaged in hand hosing tank bottoms from inside the tank shall stand on bottom of tank, and not on frames or pipe lines, etc.

J. Ventilation of tanks shall be continued while men are in tanks. This is particularly important when men are removing sediment, etc., from the tank bottoms. If ship is fitted with a gas exhauster, this device shall be used when practicable to do so, otherwise windsails shall be used. Men shall not remain in tanks if the vapor content exceeds .1 on J-W Indicator. Exception: See Paragraph 18 E.

WASHING TANKS ADJOINING COMPARTMENTS CONTAINING BULK CARGO

20. The following precautions shall be observed when washing tanks adjoining compartments containing bulk cargo:

A. Compartments adjoining tanks containing "Inflammable liquids" shall not be steamed nor washed with water having a temperature in excess of 125°F.

B. When necessary to wash cargo tanks on a vessel having bulk cargo in an adjoining compartment, adequate provision shall be made to avoid contaminating such cargo or discharging it with the washings. All valves in lines interconnecting such compartments shall be tightly closed and, if practicable, lashed in that position.

METHOD OF GAS FREEING AND/OR CLEANING TANKS

21. The method of tank cleaning to be used will vary somewhat, depending upon the degree of cleanliness required, the type of products involved, and whether or not the vessel is fitted with mechanical tank washing and/or gas exhausting equipment. Generally, the three steps given below are involved in gas freeing or cleaning of ship's tanks.

A. Removal of remaining oils.

B. Removal of vapors.

C. Final cleaning (entering tanks for removal of any remaining sediment or scale, bailing up water, wiping up moisture, etc.)

INTRODUCTION

1. These rules outline the general requirements governing replacements, alterations, dry docking or repair work which may be made aboard ship and the conditions which must be met in order to carry out such work.

2. The cleaning and gas-freeing of tanks or compartments prior to making repairs shall be carried out in accordance with "Tanker Regulation No. 2, TANK CLEANING."

3. Your attention is directed to the sections pertinent to repairs in the publication "Tank Vessels" which is issued by the Bureau of Marine Inspection and Navigation.

DEFINITIONS

4. "Repairs" as used throughout these Rules means the replacement, alteration, dry docking or repair work made to the ship or to the ship's equipment.

5. "Hot Work" is work which involves the use of fire or heat.

6. "Cold Work" is work which does not involve the use of fire or heat.

7. "Not Safe" means that vapor content of space so certified exceeds .1 on J-W Indicator.

8. "Safe for Men" Means that vapor content of space so certified is .1 or less on J-W Indicator.

9. "Safe for Men and Fire" means that vapor content of space so certified is .1 or less on J-W Indicator and there is no oil or sediment present in such space which would produce vapors.

ENTERING OR REMAINING IN TANKS

10. The conditions under which men may enter or remain in tanks or compartments are set forth in "Tanker Regulation No. 2, Tank Cleaning."

11. Master, Chief Engineer, Port Engineer and ship's officers are responsible for compliance with the spirit, as well as the letter of these rules.

12. At all times SAFETY shall be the first consideration.

13. In the event of fire on the vessel, wharf or a vessel moored nearby, the senior deck officer aboard ship shall assume responsibility for the protection of the ship and the ship's personnel and cooperate with terminal, municipal and harbor fire fighting authorities.

14. Nothing in this regulation shall be construed as limiting the Port Engineer, the Master or Chief Engineer in establishing such additional safety precautions as they may deem advisable. Should any circumstance arise which in their opinion would make repairs hazardous, such repairs shall be stopped until the condition is corrected or they are satisfied that the danger no longer exists. They shall acquaint themselves with and be responsible for compliance, consistent with this regulation, with local rules pertaining to repairs.

15. No major change shall be made in the design or grade of materials used in ship's equipment without first obtaining approval from the management. Upon completion of repairs, the Master and Chief Engineer shall report to the Management any repair work which has proven unsatisfactory as well as any other comment in regard to the work performed.

16. After completing repair work, and prior to the loading of bulk cargo or ballast, the deck officer shall assure himself that all tanks and compartments are free of rags and other materials.

17. The area surrounding a ship moored at a terminal or a shipyard shall be inspected as necessary to assure that no fire hazard exists. During hours of darkness the deck officer shall assure himself that there is adequate illumination aboard ship and at the berth, particularly in way of the gangway.

18. A copy of the list of repairs for the deck and engine departments shall be given to the officers in charge of their respective departments, who shall keep in close touch with the work as it progresses. When a ship is on drydock and work is in progress a deck officer shall be about the drydock to assist those in charge of the work.

19. In carrying out repairs, safeguards (goggles, tool guards, safety belts, etc.) shall be used by ship's personnel when necessary.

20. Prior to entering a shipyard for repairs all vessel's tanks and compartments are to be gas freed "Safe for Men and Fire."

SMOKING

21. When making repairs smoking shall be permitted at such times and in such enclosed spaces as approved by the Master, except that during cargo handling, when boiler or galley fires are prohibited, no smoking will be permitted. When all cargo tanks and compartments have been certified as "Safe for Men and Fire" and the vessel is not moored at a petroleum terminal, smoking may be allowed in certain restricted areas above deck as permitted by the Master.

MATCHES AND LIGHTERS

22. Safety matches only may be used aboard ship (any other type of matches or lighters are prohibited aboard ship." When the vessel is undergoing repairs and all tanks and compartments are not certified "Safe for Men" the carrying of safety matches by personnel engaged in making repairs is prohibited.

TESTING OF TANKS AND COMPARTMENTS

23. When indicating the vapor concentration of a tank or compartment on the "Gas Free Certificate Form P T-31," only the following terms shall be used: "Not Safe," "Safe for Men" or "Safe for Men and Fire."

24. All tests of vapor concentration for "cold work" shall be made by a qualified deck officer with the J-W Indicator prior to the commencement of repairs. When at a terminal ship's representative or terminal executive may, if he deems it necessary, require that such tests be verified by a qualified gas inspector or chemist from ashore.

25. All tests for vapor concentration for "hot work" shall be made by a qualified deck officer with the J-W Indicator prior to the commencement of repairs. When the vessel is not at a shipyard, a qualified gas inspector or chemist from ashore shall make additional tests for vapor concentration prior to commencement of "hot work" repairs. When a gas inspector is not available the tanks or compartments shall be certified to the satisfaction of the Master.

26. Upon the arrival of a vessel at a shipyard and prior to the commencement of either "hot work" or "cold work," in addition to previous tests made, a licensed chemist shall test all tanks and compartments.

27. Whenever tests for vapor concentration are made by a qualified gas inspector or a licensed chemist from ashore, the ship's officer shall obtain from him a certificate in triplicate stating the condition of all tanks and compartments.

28. If after certification, sediment in tanks or compartments is disturbed, ballast shifted, pipelines disconnected, tank tops closed, or other conditions arise which would affect the vapor content, such tanks or compartments shall be inspected or certified again, as required, before any further work is undertaken.

29. The final testing of tanks or compartments to determine their suitability for repairs shall be made after operation of gas exhauster or other means of ventilating tanks or compartments has been stopped.

30. When a chemist or gas inspector is testing the tanks or compartments he shall be accompanied by a designated member of the crew who shall be stationed on deck at the hatch when the

chemist or inspector is below decks.

31. Prior to the commencement of "hot work" repairs aboard a vessel (except as set forth in paragraphs 35A and 35B a qualified ship's officer shall test the vapor content in the space above the oil in the bunker tanks and shall inform the Master the results of the test.

"COLD WORK" REPAIRS"

32. When carrying out repairs as outlined in paragraphs 33A, 33C, and 33D, and at a terminal, the ship's officer in charge of repairs shall notify the terminal executive the nature and extent of the work to be done.

33. "Cold work" repairs may be made only under the following conditions (except emergency repairs, paragraphs 38 and 39, and when a ship has been approved for "hot work" repairs);

A. Any place on the vessel when all tanks and compartments have been certified as "Safe for Men." Pipe lines are not to be opened until they have been thoroughly flushed with water or thoroughly ventilated as required.

B. In the engine room, boiler room or living quarters at any time.

C. On the weather deck and in enclosed spaces (other than those set forth in paragraph 33B) not subject to vapor accumulation, provided there is no handling of inflammable liquids in bulk, and such repairs are made under the supervision of a qualified deck officer.

D. At or near the ends of the vessel, provided that such repairs are made under the supervision of a qualified deck officer.

"HOT WORK" REPAIRS"

34. Before carrying out "hot work" repairs, the Master shall determine that the work to be done constitutes safe procedure; when at a terminal, such repair work shall be discussed with the terminal executive and a mutual agreement reached before the commencement of repairs.

35. "Hot work" repairs may be made only under the following conditions:

A. In the engine room and boiler room when boiler fires are permitted, provided that the spaces (bilges, etc.) which may be subject to vapor accumulation have been tested for "hot work" repairs. Such repairs must be carried out under the constant supervision of a qualified engineer officer.

B. At or near the ends of the vessel provided there is no movement of bulk cargo or inflammable liquids in packages on the vessel, and no movement of inflammable liquids through a hose or into ship's cargo tank which tank or hose is within 200 feet of the work being performed. Such work must be carried out under the constant supervision of a qualified deck officer.

C. Any place on the vessel when all tanks and compartments have been certified "Safe for Men and Fire," provided paragraphs 36 and 37 are complied with.

D. In a tank or compartment provided all tanks and compartments are certified "Safe for Men" and the space in which the "hot work" repairs are to be made, and adjoining spaces, are certified "Safe for Men and Fire," and paragraphs 36 and 37 are complied with.

E. On the weather deck, in the living quarters or other enclosed spaces above the weather deck not subject to vapor accumulation, when all tanks and compartments are certified "Safe for Men" provided paragraphs 36 and 37 are complied with; except this work cannot be done on or immediately adjacent to the tank hatches.

F. On oil and vapor pipe lines after they have been thoroughly flushed with water or ventilated as is necessary and disconnected (no such pipe lines shall be burned into until they have first been disconnected.)

36. When a bunker tank contains bunker oil and the vapor content of the space above the oil tests .1 or less on the J-W Indicator, "hot work" may be carried out as contemplated in paragraphs 35C, 35D and 35E except that no "hot work" may be done on the deck, bulkheads or shell plating of the bunker tank without first obtaining approval from the Master.

37. Prior to carrying out repairs as set forth in paragraphs 35C, 35D and 35E all cargo lines and pumps are to be thoroughly flushed with water and auxiliary lines, venting system, heating coils, smothering lines, etc., are to be thoroughly blown out with steam or washed out if steam is not available.

EMERGENCY REPAIRS

38. Emergency "cold work" repairs of a minor nature may be carried out in a tank or compartment which has been certified as "Safe for Men" when the remainder of the tanks and compartments are not so certified, provided there is no movement of cargo aboard ship and all valves on cargo and auxiliary pipe lines interconnecting such spaces with other tanks or compartments are closed and lashed. Such repairs must be carried out under the constant supervision of a qualified deck officer.

39. Emergency "cold work" repairs may be carried out in a tank or compartment the vapor content of which is greater than .1 on the J-W Indicator or which last contained noxious gas and has not been properly ventilated, providing all necessary precautions have been taken. These repairs may only be made if competent men are fitted with fresh air type gas mask and life lines and the work is carried out under direct supervision of the Master or a qualified deck officer.

TEMPORARY LIGHTING

40. Only approved flashlights in first class condition may be used aboard ship; such lights may be used at any time.

41. The use of temporary lights during repairs shall be controlled as follows:

A. When emergency repairs are made in a tank or compartment, the vapor content of which exceeds .1 on the J-W Indicator, only approved flashlights of vapor proof type in first class condition may be used..

B. When a tank or compartment in which lights are required has been certified as "Safe for Men," only approved portable lighting equipment of vapor proof type in first class condition may be used. Care shall be taken that the portable plug-in-boxes are remote from the tank tops and a qualified person is on duty to handle such equipment. The lights shall be secured (but not by means of the electrical cable) and shall not be moved in or out of a tank or compartment until disconnected from the plug-in-boxes.

C. When undergoing repairs at a shipyard and the vessel has been approved for "hot work" repairs, the shipyard will furnish portable lighting equipment and superintend its use.

ELECTRICAL CIRCUIT REPAIRS

42. Before making repairs on an electric circuit, or changing globes in the pumproom, forehold, 'tween deck or other spaces subject to vapor accumulation, the controlling switch for the entire circuit shall be opened and so marked until the repairs have been completed.

ADVANCE NOTICE OF REPAIRS

43. When repairs are required on arrival, which may necessitate advance preparation at the port of destination, in order to avoid delays to the ship, the Master shall telegraph prior to learning the last port of call the particulars of manpower required and the complete description, dimensions and other data of the work to be done as far as it is practicable.

CREW DURING REPAIR PERIOD

44. Vessels shall comply with port security regulations regarding minimum crew required aboard.

45. A ship with steam up shall have on duty at all times at least a deck officer, an engineer officer and crew members as required. One seaman shall maintain a continuous gangway watch.

46. When in the opinion of the Master or the senior deck officer conditions warrant, additional guards shall be obtained and members of the crew detailed as watchmen.

TRIM FOR DRYDOCKING

47. A ship going on drydock is to be trimmed as light and as close to an even keel as practicable. In no case is the ship to be by the head, nor more than six feet by the stern. While a ship is in drydock there shall be no movements of weights or ballast (whereby the trim might be altered when refloated) without first obtaining permission from the Port Engineer or Master and drydock foreman.

48. When a ship is on drydock and water is drained from the pipeline system and tanks through the bleeder plugs, particular care shall be taken that this water does not contain traces of oil. These plugs may only be removed with the approval of the Port Engineer or the Master.

REPAIRS IN FOREIGN PORTS (DUTIABLE)

49. Since there is a heavy duty imposed by this country on certain repairs made and equipment purchased by the United States vessels in a foreign country, it is the policy of the Company not to have repairs made or equipment purchased in a foreign country except in case of emergency. In the event such purchases or repairs (except minor repairs or purchases) are absolutely necessary in a foreign country, approval must first be obtained from the W.S.A. representative. It is important that invoices shall be made out in quintuplicate showing the prices charged and should be receipted as paid. Upon the return of the vessel to the United States, the Master shall, at the Custom House of the first port of entry, make out an affidavit covering all equipment purchased and repairs and the nature and circumstances under which these repairs or purchases were made. If no repairs have been made or equipment purchased in a foreign country, the affidavit is to be made out to this effect. Since emergency repairs or purchases might be exempted from duty, the Master shall claim exemption on all emergency repairs and equipment purchases. Claims for exemption must be accompanied with detailed explanation of the circumstances which occasioned the emergency repairs. Extracts from the Log Book and a detailed report from the Master and Chief Engineer are particularly important.

REPAIR SPECIFICATIONS

50. Prior to each repair period, repair specifications shall be prepared and signed by the Master and Chief Engineer covering all intended repairs. The specifications shall be made out on Form PT-17 in quintuplicate, four copies of which are to be sent to the Management (when practicable) at least ten days prior to the ship's arrival for repairs. These repair specifications shall be made out in the following three classifications:- Deck Department; Engine Department and Stewards Department. A supplementary ship's repair specifications form, shall be made out if additional repairs are found necessary after sending in the original list. This supplementary list should be sent to this office as soon as practicable.

BALLASTING OF TANK VESSELS

As the result of recent research into various methods of ballasting tankers, coupled with the knowledge gained from experience in operating tank vessels, we are establishing some basic principles and rules which are to be observed in the future ballasting of our tank vessels.

There are in ballasting two major points to be considered; the reduction of vibrations in the ship resulting from the effect of the propulsion plant, and the stresses set up in the hull by the unequal distribution of the weight throughout the ship accentuated by the action of the sea.

It is not to be understood that these two factors are independent and unrelated, for as you are aware, the amount and position of the ballast has a very definite effect upon vibrations. They are, however, sufficiently different to permit us to consider them separately.

Vibrations which arise in the vessel are ordinarily produced by the propelling unit in combination with the vibrations of the hull structure. The general vibrations are further influenced by whether or not the period of the hull and machinery coincide (in this connection the engine room staff and the deck department will cooperate to avoid this condition), and to a lesser extent the vibrations which are set up by the hull pounding in a disturbed sea. Vibrations are also a condition characteristic of each ship, no two ships being alike in this respect. Not only do vibrations vary with each ship, but they also vary in each ship with different distributions of weight, sea conditions, age of the vessel, speed, etc. These vibratory conditions are observable and should be eliminated as far as possible.

The major stress set up in a vessel is the result of the relationship between weight and buoyancy and results in shearing and bending stresses. It is, of course, apparent that the above mentioned stresses will vary with the distribution of the weights and the condition of the sea. Such stresses, although not identical for every ship of the same type, are sufficiently similar for certain conclusions to be drawn from the field of research under practical and theoretical conditions wherein some measurements have been made as to their extent and the effect produced. Furthermore, investigations of structural failures, especially in the case of the bottom shell and decks on tank vessels, have indicated that these were brought about in a large measure by exceptionally high stresses which were caused by improper ballasting.

The major objectives of all ballasting are to reduce the vibrations to a minimum and to avoid undue structural stresses. The reduction of vibrations is a matter which must, of necessity, be left to the Master of each vessel to control. The stresses within the structure of the ship may be to a large extent reduced by following the ballasting procedure herein set forth.

Consistent with the overall efficient operation of the ship you will in the future carry out the ballasting policy hereinafter outlined.

A tank vessel in a normal loaded condition will have a tendency to set up a sagging condition. This sagging is a result of the weight of the cargo in the cargo tank section of the vessel. It will be most noticeable near the longitudinal center of the ship and may result in excessive stresses if the weight is concentrated in the longitudinal center of the cargo tank section. This sagging can, at least in part, be eliminated if the weight is distributed in the end tanks with a corresponding reduction of the weight in the center tanks. It is, therefore, suggested, whenever practicable, outages should be carried in the center tanks. (See page 6.)

A tank vessel in a light condition has a tendency to hog. This condition is the result of the weight in the stern section of the ship and of the normal weight of the forward end of the vessel. Under this condition the center section of the ship largely carries the resulting stresses. (See pages No. 1 & 2). These stresses, which are usually excessive, can be avoided by a judicious equalization of the weight in the ship. Vessels shall, therefore, carry the ballast so as to maintain as nearly as possible an even distribution of weight throughout the structure of the ship, having in mind the concentration of weight in the stern section due to the engines, boilers, bunkers and water, as well as bunkers or water which may be located elsewhere in the vessel.

Consistent with the reduction of vibrations within your ship, it is suggested that the initial tank to be ballasted will be the first tank forward of the longitudinal center of the ship, and that if additional ballast is needed to meet weather conditions alternate tanks forward and aft from the first tank ballasted. As an example: as the longitudinal center of the vessel is located in No. 6 tank, ballast will first be loaded into No. 5 tank. If additional ballast is needed, No. 3 and No. 7 will be loaded, and if further ballast is needed, No. 1 and No. 9 will be loaded.

Vessels proceeding to dry docking shall have ballast properly distributed in the ship, and not concentrated in the forward tanks until the ship is in smooth water. In entering a floating or graving dry dock the vessel should be as nearly on an even keel as practicable. To insure safety and facilitate proper handling in the dry docking, the vessel should not trim more than six feet by the stern.

The carrying of ballast in slack tanks should be avoided as much as possible under any condition except good weather, and then should be minimized.

The carrying of ballast only in the foredeep or forepeak tanks at sea is not advisable procedure, and we suggest that it be discontinued except where extreme conditions may warrant it. (See page 2.)

No vessel is to leave a dock or outside mooring until sufficient ballast has been loaded to meet the prevailing weather conditions having due regard for bar conditions, the likelihood of the vessel pounding, and such other contingencies as may arise. The ship shall be ballasted at all times so as to prevent undue structural stresses. It should also be borne in mind that the propulsion power and maneuvering qualities of a ship are, to a large extent, reduced as the propeller blades are exposed above the water.

Inasmuch as Weather conditions are entered in the Log book, you are to keep an accurate record of ballasting in this book, the time and sequence in which the tank or tanks were filled, or emptied,

In carrying out the ballast procedures herein outlined you will of necessity be required to meet varying conditions which may result in certain deviations from the above rules. In this connection you will be guided by your judgment in reference to the particular requirements of your ship and the prevailing weather conditions. The basic principles, however, the reduction of vibrations, and the equal distribution of weight throughout the ship, are to be as closely adhered to as practicable. (See page 5).

Diagrams illustrating certain ballasting methods and the resulting stresses which a vessel is subjected to are contained in attached prints. You and your officers are to thoroughly acquaint yourself with this material so you will be in a better position to carry out the ballasting policy herein outlined. It is also intended that this material will become a source of reference and will be of assistance to you in working out any particular ballasting problems which may confront you. We wish to call your attention to (page 5) which offers the best method of ballasting a tank vessel, and suggest that you give this illustration close study. It is hoped that Captains, Chief Engineers and other officers will avail themselves of the opportunity of viewing these diagrams and discussing the problems involved with the Management. The Management also welcomes suggestions and comments from Captains, Chief Engineers and others interested in this important subject.

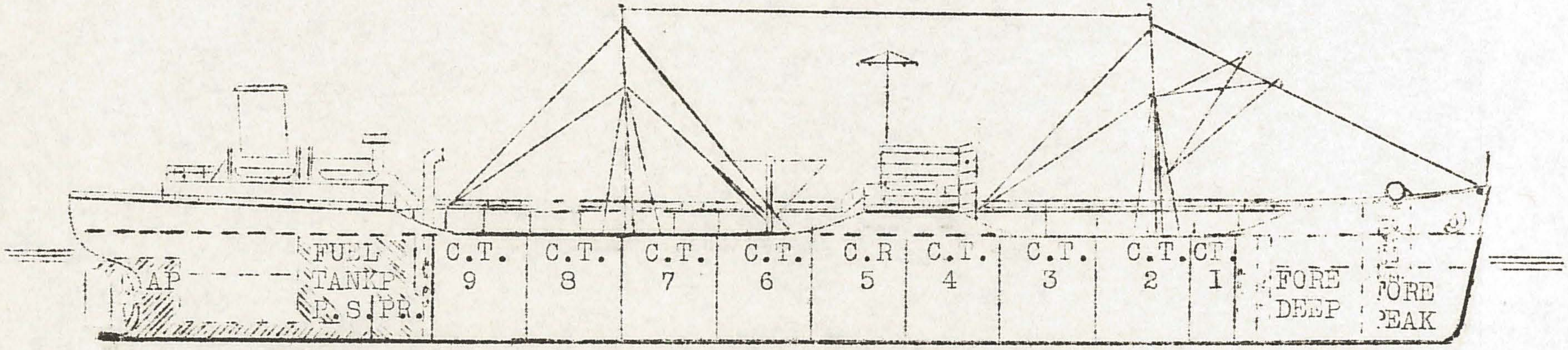


FIG. 1
NOTE THE EXTREME BENDING ACTION CAUSED BY LACK OF EVENLY DISTRIBUTED WEIGHT WITHIN THE SHIPS STRUCTURE.

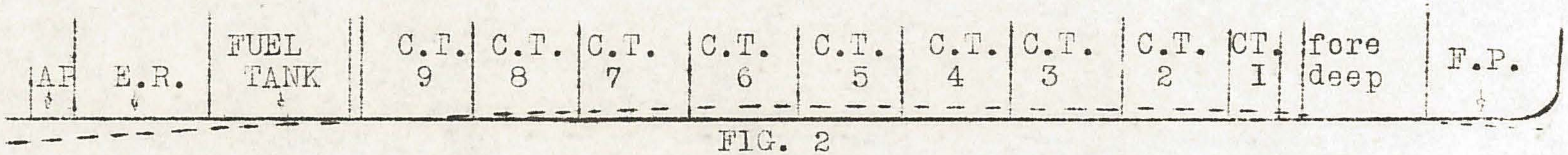


FIG. 2
DEFLECTION DIAGRAM

———————— = NORMAL KEEL LINE

- - - - - - - - = TENDENCY TO DEFLECT FROM NORMAL LINE DUE TO WEIGHT DISTRIBUTION

SKETCH 1

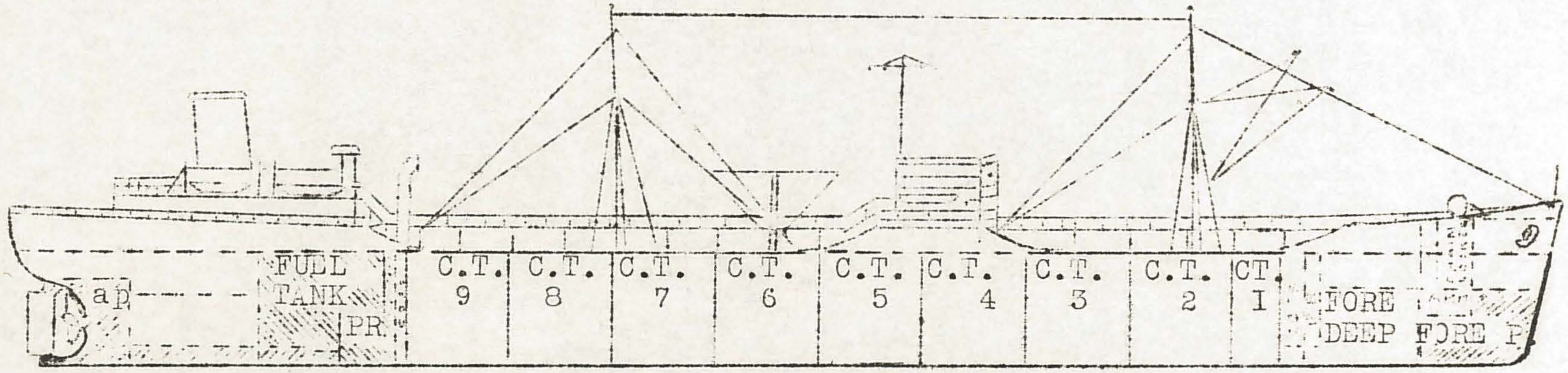


FIG. I
NOTE THE LONG AMIDSHIP SECTION WITHOUT BALLAST: THE WEIGHT BEING CONCENTRATED IN THE EXTREME ENDS OF THE SHIP. THIS METHOD OF BALLASTING IS HIGHLY UNDESIRABLE.

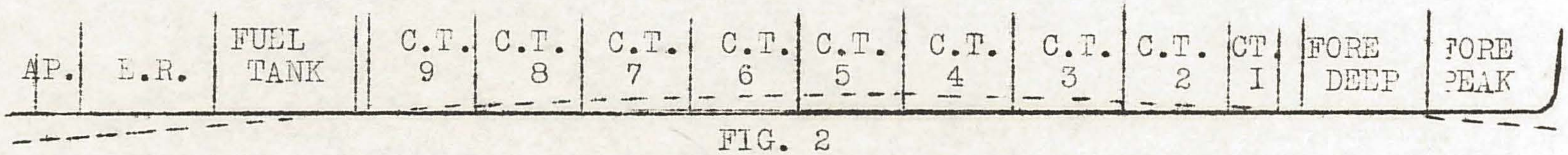


FIG. 2
DEFLECTION DIAGRAM

———————— = NORMAL KEEL LINE

- - - - - - - - = TENDENCY TO DEFLECT FROM NORMAL LINE
DUE TO WEIGHT DISTRIBUYION.

SKETCH 2

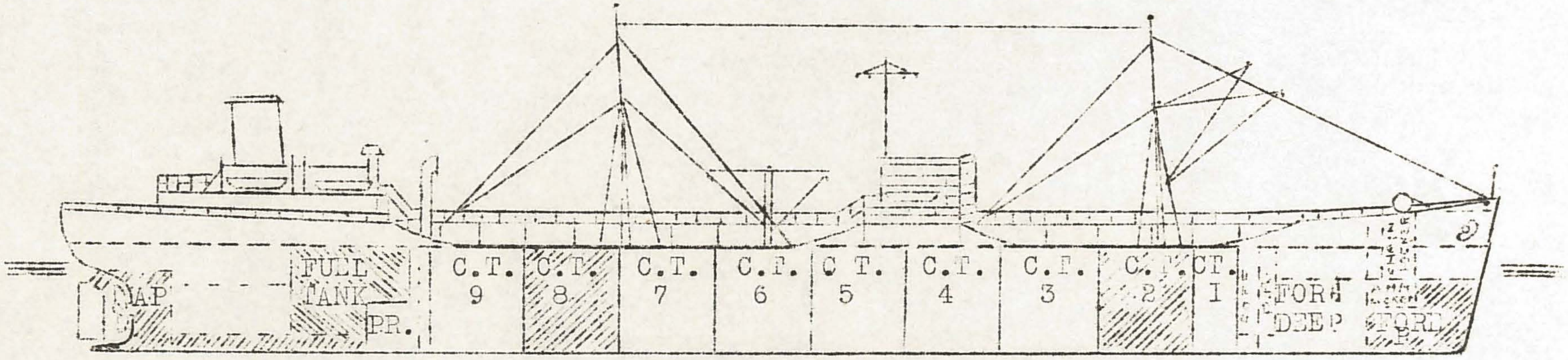


FIG. 1

note THE AMIDSHIP SECTION OF THE SHIP WITHOUT BALLAST
AND THE UNEVEN DISTRIBUTION OF WEIGHT THROUGHOUT THE SHIP.

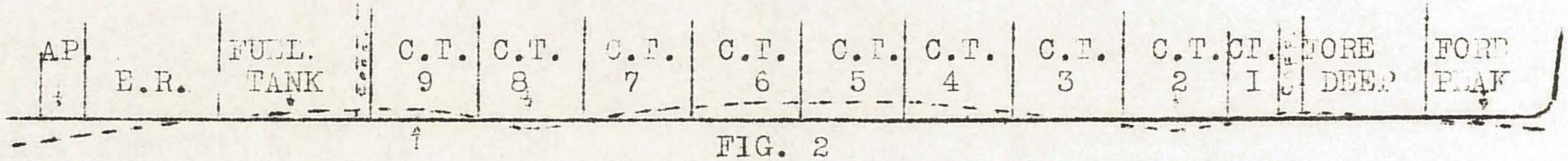


FIG. 2

DEFLECTION DIAGRAM

———— = NORMAL KEEL LINE

- - - - - - - = TENDENCY TO DEFLECT FROM NORMAL LINE
DUE TO WEIGHT DISTRIBUTION.

SKETCH 3

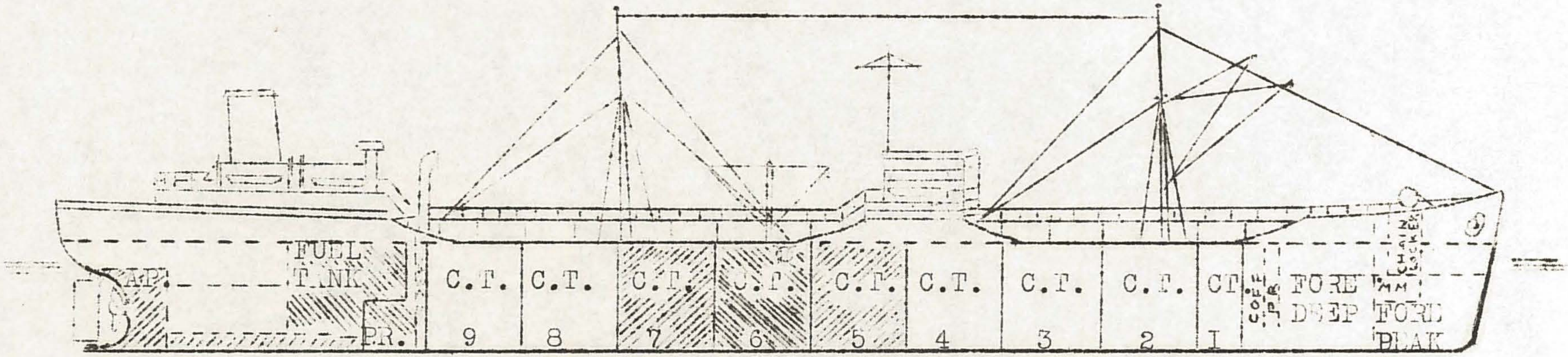


FIG. I

NOTE THE SAGGING TENDENCY CAUSED BY THE HEAVY CONCENTRATION OF BALLAST IN THE CENTER TANKS.

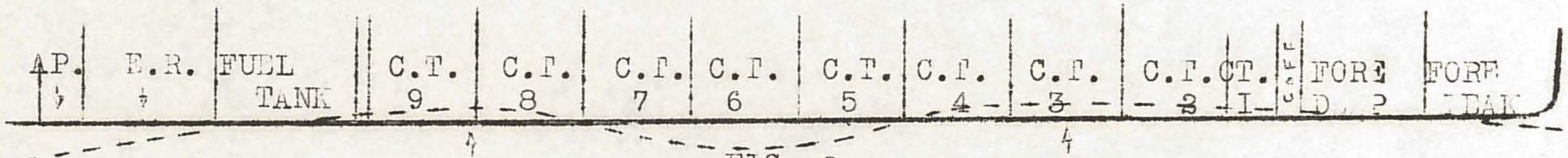


FIG. 2

DEFLECTION DIAGRAM

——— = NORMAL KEEL LINE

- - - - - - = TENDENCY TO DEFLECT FROM NORMAL LINE DUE TO WEIGHT DISTRIBUTION.

SKETCH 4

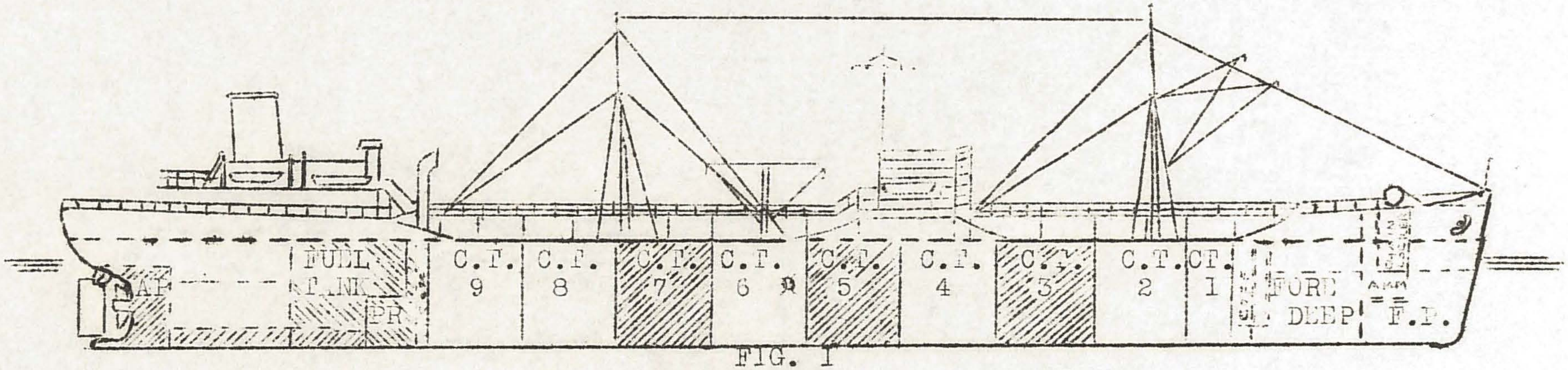


FIG. 1

NOTE THE NEARLY EQUAL DISTRIBUTION OF WEIGHT THROUGHOUT THE SHIPS STRUCTURE WITH RESULTANT REDUCTION IN THE BENDING STRESS. THIS METHOD OF BALLASTING OFFERS THE BEST CONDITION AND PREVENTS EXCESSIVE STRESSES ON ANY ONE SECTION OF THE SHIP.

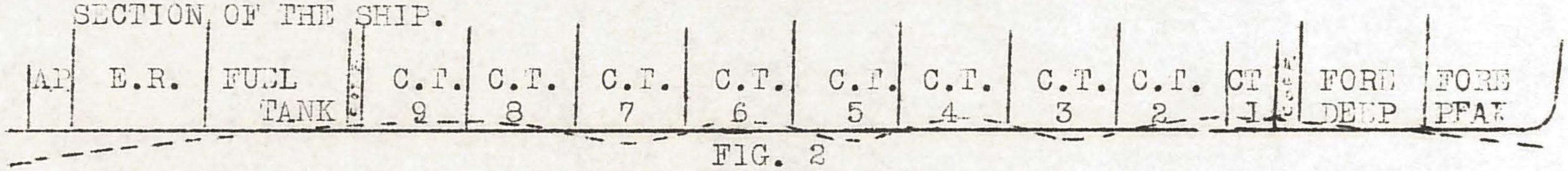


FIG. 2
DEFLECTION DIAGRAM

——— = NORMAL KEEL LINE

- - - - - = TENDENCY TO DEFLECT FROM NORMAL LINE DUE TO WEIGHT DISTRIBUTION.

SKETCH 5

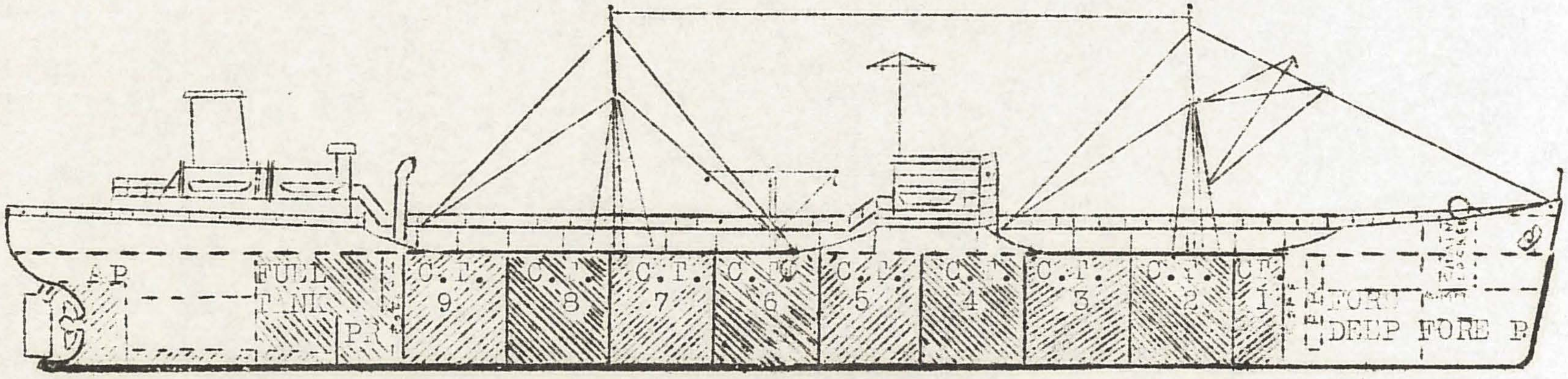


FIG. 1
A TANK SHIP IN FULLY LOADED CONDITION HAS A TENDENCY TO SAG. IT IS ADVISABLE TO MINIMIZE THIS CONDITION AS MUCH AS POSSIBLE BY CARRYING OUTAGES, WHENEVER PRACTICABLE, IN TANKS NEAR THE CENTER OF THE SHIP.

SKETCH 6

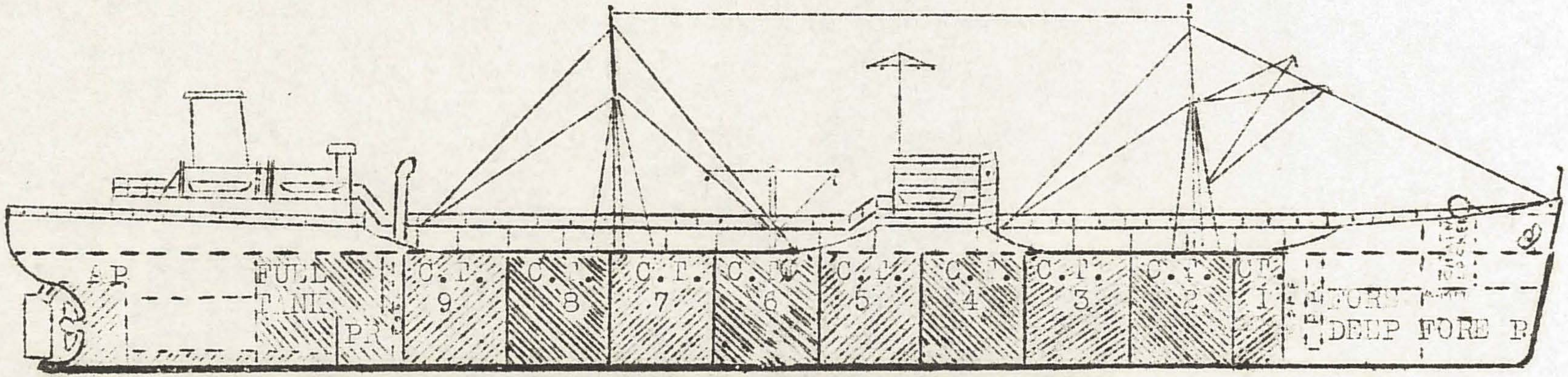


FIG. 1

A TANK SHIP IN FULLY LOADED CONDITION HAS A TENDENCY TO SAG. IT IS ADVISABLE TO MINIMIZE THIS CONDITION AS MUCH AS POSSIBLE BY CARRYING OUTAGES, WHENEVER PRACTICABLE, IN TANKS NEAR THE CENTER OF THE SHIP.

SKETCH 6

PETROLEUM - HANDBOOK

REPRODUCED BY PERMISSION

OF

CHAS. MARTIN & CO

INSPECTORS OF PETROLEUM

AND ITS PRODUCTS

TANK STRAPPING

AND

CALIBRATION

MAIN OFFICE

K-NO 1 PRODUCED - EXCHANGE

ANNEX

NEW YORK, N.Y.

MD 199

REVISED PETROLEUM TABLES

Compiled by Chas. Martin & Co. from tables and data published by U. S. Department of Commerce, U. S. Bureau of Standards, American Society for Testing Materials, C. J. Tagliabue Manufacturing Company, and other acceptable authorities.

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1941 EDITION

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A.P.I. Gravity, Specific Gravity, Pounds per U. S. Gallon, Barrels per Ton and Cubic Feet per Ton.............. 1
(Barrels per Ton and Cubic Feet per Ton are approximate; other tables exact)

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NOTE: The word 'TON' wherever used in these pages, refers to the Long Ton of 2240 pounds.

A.P.I. Grav.	Spec. Grav.	Lbs. Per Gal.	Bbls. Per Ton	Cu. Ft. Per Ton
00.0	1.0760	8.962	5.951	33.41
.1	1.0752	8.956	5.955	33.44
.2	1.0744	8.949	5.960	33.46
.3	1.0736	8.942	5.964	33.49
.4	1.0728	8.935	5.969	33.51
.5	1.0720	8.928	5.974	33.54
.6	1.0712	8.922	5.978	33.56
.7	1.0703	8.915	5.982	33.59
.8	1.0695	8.908	5.987	33.61
.9	1.0687	8.901	5.992	33.64

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A.P.I. Grav.	Spec. Grav.	Lbs. Per Gal.	Bbls. Per Ton	Cu. Ft. Per Ton
1.0	1.0679	8.895	5.996	33.66
.1	1.0671	8.888	6.001	33.69
.2	1.0663	8.881	6.005	33.72
.3	1.0655	8.875	6.009	33.74
.4	1.0647	8.868	6.014	33.77
.5	1.0639	8.861	6.019	33.79
.6	1.0631	8.855	6.023	33.82
.7	1.0623	8.848	6.028	33.84
.8	1.0615	8.841	6.033	33.87
.9	1.0607	8.835	6.037	33.89
2.0	1.0599	8.828	6.041	33.92
.1	1.0591	8.821	6.046	33.95
.2	1.0583	8.815	6.050	33.97
.3	1.0575	8.808	6.055	34.00
.4	1.0568	8.802	6.059	34.02
.5	1.0560	8.795	6.064	34.05
.6	1.0552	8.788	6.069	34.07
.7	1.0544	8.732	6.073	34.10
.8	1.0536	8.775	6.078	34.12
.9	1.0528	8.769	6.082	34.15
3.0	1.0520	8.762	6.087	34.18
.1	1.0513	8.756	6.091	34.20
.2	1.0505	8.749	6.096	34.23
.3	1.0497	8.743	6.100	34.25
.4	1.0489	8.736	6.105	34.28
.5	1.0481	8.730	6.109	34.30
.6	1.0474	8.723	6.114	34.33
.7	1.0466	8.717	6.118	34.35
.8	1.0458	8.710	6.123	34.38
.9	1.0451	8.704	6.127	34.40
4.0	1.0443	8.698	6.132	34.43
.1	1.0435	8.691	6.137	34.45
.2	1.0427	8.685	6.141	34.48
.3	1.0420	8.678	6.146	34.51
.4	1.0412	8.672	6.150	34.53
.5	1.0404	8.666	6.154	34.55
.6	1.0397	8.659	6.159	34.58
.7	1.0389	8.653	6.164	34.61
.8	1.0382	8.646	6.169	34.63
.9	1.0374	8.640	6.173	34.66
5.0	1.0366	8.634	6.177	34.68
.1	1.0359	8.627	6.182	34.71
.2	1.0351	8.621	6.186	34.73
.3	1.0344	8.615	6.191	34.76
.4	1.0336	8.608	6.195	34.79
.5	1.0328	8.602	6.200	34.81
.6	1.0321	8.596	6.204	34.84
.7	1.0313	8.590	6.209	34.86
.8	1.0306	8.583	6.214	34.89
.9	1.0298	8.577	6.218	34.91
6.0	1.0291	8.571	6.223	34.94
.1	1.0283	8.565	6.227	34.96
.2	1.0276	3.553	6.232	34.99

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A.P.I. Grav.	Spec. Grav.	Lbs. Per Gal.	Bbls. Per Ton	Cu. Ft. Per Ton
.3	1.0269	8.552	6.236	35.01
.4	1.0261	8.546	6.241	35.04
.5	1.0254	8.540	6.245	35.06
.6	1.0246	8.534	6.250	35.09
.7	1.0239	8.527	6.255	35.12
.8	1.0231	8.521	6.259	35.14
.9	1.0224	8.515	6.263	35.17
7.0	1.0217	8.509	6.268	35.19
.1	1.0209	8.503	6.272	35.22
.2	1.0202	8.497	6.277	35.24
.3	1.0195	8.490	6.282	35.27
.4	1.0187	8.484	6.286	35.30
.5	1.0180	8.478	6.291	35.32
.6	1.0173	8.472	6.295	35.35
.7	1.0165	8.466	6.300	35.37
.8	1.0158	8.460	6.304	35.40
.9	1.0151	8.454	6.309	35.42
8.0	1.0143	8.448	6.313	35.45
.1	1.0136	8.442	6.318	35.47
.2	1.0129	8.436	6.322	35.50
.3	1.0122	8.430	6.327	35.52
.4	1.0114	8.424	6.331	35.55
.5	1.0107	8.418	6.336	35.57
.6	1.0100	8.412	6.340	35.60
.7	1.0093	8.406	6.345	35.62
.8	1.0086	8.400	6.349	35.65
.9	1.0078	8.394	6.354	35.67
9.0	1.0071	8.388	6.358	35.70
.1	1.0064	8.382	6.363	35.73
.2	1.0057	8.376	6.367	35.75
.3	1.0050	8.370	6.372	35.78
.4	1.0043	8.364	6.377	35.80
.5	1.0035	8.358	6.381	35.83
.6	1.0028	8.352	6.386	35.85
.7	1.0021	8.346	6.390	35.88
.8	1.0014	8.340	6.395	35.90
.9	1.0007	8.334	6.399	35.93
10.0	1.0000	8.328	6.404	35.95
.1	.9993	8.322	6.409	35.98
.2	.9986	8.317	6.413	36.00
.3	.9979	8.311	6.417	36.03
.4	.9972	8.305	6.422	36.05
.5	.9965	8.299	6.426	36.08
.6	.9958	8.293	6.431	36.10
.7	.9951	8.287	6.436	36.13
.8	.9944	8.282	6.440	36.15
.9	.9937	8.276	6.444	36.18
11.0	.9930	8.270	6.449	36.21
.1	.9923	8.264	6.454	36.23
.2	.9916	8.258	6.458	36.26
.3	.9909	8.252	6.463	36.29
.4	.9902	8.246	6.468	36.31
.5	.9895	8.241	6.472	36.34

A.P.I. Grav.	Spec. Grav.	Lbs. Per Gal.	Bbls. Per Ton	Cu. Ft. Per Ton
.6	.9888	8.235	6.476	36.36
.7	.9881	8.229	6.481	36.39
.8	.9874	8.223	6.486	36.41
.9	.9868	8.218	6.490	36.44
12.0	.9861	8.212	6.495	36.47
.1	.9854	8.206	6.499	36.49
.2	.9847	8.201	6.503	36.51
.3	.9840	8.195	6.508	36.54
.4	.9833	8.189	6.513	36.57
.5	.9826	8.183	6.518	36.59
.6	.9820	8.178	6.522	36.62
.7	.9813	8.172	6.526	36.64
.8	.9806	8.166	6.531	36.67
.9	.9799	8.161	6.535	36.69
13.0	.9792	8.155	6.540	36.72
.1	.9786	8.150	6.544	36.74
.2	.9779	8.144	6.549	36.77
.3	.9772	8.138	6.554	36.80
.4	.9765	8.132	6.558	36.82
.5	.9759	8.127	6.562	36.84
.6	.9752	8.122	6.567	36.87
.7	.9745	8.116	6.571	36.89
.8	.9738	8.110	6.576	36.92
.9	.9732	8.105	6.580	36.94
14.0	.9725	8.099	6.585	36.97
.1	.9718	8.093	6.590	37.00
.2	.9712	8.088	6.594	37.02
.3	.9705	8.082	6.599	37.05
.4	.9698	8.076	6.604	37.08
.5	.9692	8.071	6.608	37.10
.6	.9685	8.066	6.612	37.12
.7	.9679	8.061	6.616	37.14
.8	.9672	8.055	6.621	37.17
.9	.9665	8.049	6.626	37.20
15.0	.9659	8.044	6.630	37.22
.1	.9652	8.038	6.635	37.25
.2	.9646	8.033	6.639	37.27
.3	.9639	8.027	6.644	37.30
.4	.9632	8.021	6.649	37.33
.5	.9626	8.016	6.653	37.35
.6	.9619	8.011	6.658	37.38
.7	.9613	8.006	6.662	37.40
.8	.9606	8.000	6.667	37.43
.9	.9600	7.995	6.671	37.45
16.0	.9593	7.989	6.676	37.48
.1	.9587	7.984	6.680	37.50
.2	.9580	7.978	6.685	37.53
.3	.9574	7.973	6.689	37.55
.4	.9567	7.967	6.694	37.58
.5	.9561	7.962	6.698	37.60
.6	.9554	7.956	6.704	37.64
.7	.9548	7.951	6.708	37.66
.8	.9541	7.946	6.712	37.68
.9	.9535	7.940	6.717	37.71

A.P.I. Grav.	Spec. Grav.	Lbs. Per Gal.	Bbls. Per Ton	Cu. Ft. Per Ton
17.0	.9529	7.935	6.721	37.73
.1	.9522	7.930	6.726	37.76
.2	.9516	7.925	6.730	37.78
.3	.9509	7.919	6.735	37.81
.4	.9503	7.914	6.739	37.84
.5	.9497	7.909	6.743	37.86
.6	.9490	7.903	6.748	37.89
.7	.9484	7.898	6.753	37.91
.8	.9478	7.893	6.757	37.94
.9	.9471	7.887	6.762	37.96
18.0	.9465	7.882	6.766	37.99
.1	.9459	7.877	6.771	38.01
.2	.9452	7.871	6.776	38.04
.3	.9446	7.866	6.780	38.07
.4	.9440	7.861	6.785	38.09
.5	.9433	7.856	6.789	38.12
.6	.9427	7.851	6.793	38.14
.7	.9421	7.846	6.798	38.17
.8	.9415	7.841	6.802	38.19
.9	.9408	7.835	6.807	38.22
19.0	.9402	7.830	6.811	38.24
.1	.9396	7.825	6.816	38.27
.2	.9390	7.820	6.820	38.29
.3	.9383	7.814	6.825	38.32
.4	.9377	7.809	6.830	38.35
.5	.9371	7.804	6.834	38.37
.6	.9365	7.799	6.838	38.39
.7	.9358	7.793	6.844	38.42
.8	.9352	7.788	6.848	38.45
.9	.9346	7.783	6.853	38.48
20.0	.9340	7.778	6.857	38.50
.1	.9334	7.773	6.861	38.53
.2	.9328	7.768	6.866	38.55
.3	.9321	7.762	6.871	38.58
.4	.9315	7.757	6.876	38.60
.5	.9309	7.752	6.880	38.63
.6	.9303	7.747	6.884	38.65
.7	.9297	7.742	6.889	38.68
.8	.9291	7.737	6.893	38.70
.9	.9285	7.732	6.898	38.73
21.0	.9279	7.727	6.902	38.75
.1	.9273	7.722	6.907	38.78
.2	.9267	7.717	6.911	38.80
.3	.9260	7.711	6.917	38.83
.4	.9254	7.706	6.921	38.86
.5	.9248	7.701	6.926	38.89
.6	.9242	7.696	6.930	38.91
.7	.9236	7.691	6.935	38.94
.8	.9230	7.686	6.939	38.96
.9	.9224	7.681	6.944	38.99
22.0	.9218	7.676	6.948	39.01
.1	.9212	7.671	6.953	39.04
.2	.9206	7.666	6.957	39.06

A.P.I. Grav.	Spec. Grav.	Lbs. Per Gal.	Bbls. Per Ton	Cu. Ft. Per Ton
.3	.9200	7.661	6.962	39.09
.4	.9194	7.656	6.966	39.11
.5	.9188	7.651	6.971	39.14
.6	.9182	7.646	6.975	39.16
.7	.9176	7.641	6.980	39.19
.8	.9170	7.636	6.984	39.21
.9	.9165	7.632	6.988	39.23
23.0	.9159	7.627	6.993	39.26
.1	.9153	7.622	6.997	39.28
.2	.9147	7.617	7.002	39.31
.3	.9141	7.612	7.006	39.33
.4	.9135	7.607	7.011	39.36
.5	.9129	7.602	7.016	39.38
.6	.9123	7.597	7.020	39.41
.7	.9117	7.592	7.025	39.44
.8	.9111	7.587	7.030	39.46
.9	.9106	7.583	7.033	39.48
24.0	.9100	7.578	7.038	39.51
.1	.9094	7.573	7.043	39.54
.2	.9088	7.568	7.047	39.56
.3	.9082	7.563	7.052	39.59
.4	.9076	7.558	7.057	39.62
.5	.9071	7.554	7.060	39.64
.6	.9065	7.549	7.065	39.67
.7	.9059	7.544	7.070	39.69
.8	.9053	7.539	7.074	39.72
.9	.9047	7.534	7.079	39.75
25.0	.9042	7.529	7.084	39.77
.1	.9036	7.524	7.088	39.79
.2	.9030	7.519	7.093	39.82
.3	.9024	7.514	7.098	39.85
.4	.9018	7.509	7.103	39.88
.5	.9013	7.505	7.106	39.90
.6	.9007	7.500	7.111	39.92
.7	.9001	7.495	7.116	39.95
.8	.8996	7.491	7.120	39.97
.9	.8990	7.486	7.124	40.00
26.0	.8984	7.481	7.129	40.02
.1	.8978	7.476	7.134	40.05
.2	.8973	7.472	7.138	40.08
.3	.8967	7.467	7.143	40.10
.4	.8961	7.462	7.147	40.13
.5	.8956	7.458	7.151	40.15
.6	.8950	7.453	7.156	40.18
.7	.8944	7.448	7.161	40.20
.8	.8939	7.443	7.166	40.23
.9	.8933	7.438	7.170	40.25
27.0	.8927	7.434	7.174	40.28
.1	.8922	7.429	7.179	40.31
.2	.8916	7.424	7.184	40.33
.3	.8911	7.420	7.188	40.36
.4	.8905	7.415	7.193	40.38
.5	.8899	7.410	7.197	40.41

A.P.I. Grav.	Spec. Grav.	Lbs. Per Gal.	Bbls. Per Ton	Cu. Ft. Per Ton
.6	.8894	7.406	7.201	40.43
.7	.8888	7.401	7.206	40.46
.8	.8883	7.397	7.210	40.48
.9	.8877	7.392	7.215	40.51
28.0	.8871	7.387	7.220	40.54
.1	.8866	7.383	7.224	40.56
.2	.8860	7.378	7.229	40.59
.3	.8855	7.373	7.234	40.61
.4	.8849	7.368	7.239	40.64
.5	.8844	7.364	7.242	40.66
.6	.8838	7.360	7.246	40.68
.7	.8833	7.355	7.251	40.71
.8	.8827	7.351	7.255	40.73
.9	.8822	7.346	7.260	40.76
29.0	.8816	7.341	7.265	40.79
.1	.8811	7.337	7.269	40.81
.2	.8805	7.332	7.274	40.84
.3	.8800	7.328	7.278	40.86
.4	.8794	7.323	7.283	40.89
.5	.8789	7.318	7.288	40.92
.6	.8783	7.314	7.292	40.94
.7	.8778	7.309	7.297	40.97
.8	.8772	7.305	7.301	40.99
.9	.8767	7.300	7.306	41.02
30.0	.8762	7.296	7.310	41.04
.1	.8756	7.291	7.315	41.07
.2	.8751	7.287	7.319	41.09
.3	.8745	7.282	7.324	41.12
.4	.8740	7.278	7.328	41.14
.5	.8735	7.273	7.333	41.17
.6	.8729	7.268	7.338	41.20
.7	.8724	7.264	7.342	41.22
.8	.8718	7.259	7.347	41.25
.9	.8713	7.255	7.351	41.27
31.0	.8708	7.251	7.355	41.29
.1	.8702	7.246	7.360	41.32
.2	.8697	7.242	7.364	41.34
.3	.8692	7.238	7.369	41.37
.4	.8686	7.233	7.374	41.40
.5	.8681	7.228	7.379	41.43
.6	.8676	7.224	7.383	41.45
.7	.8670	7.219	7.388	41.48
.8	.8665	7.215	7.392	41.50
.9	.8660	7.211	7.396	41.52
32.0	.8654	7.206	7.401	41.55
.1	.8649	7.202	7.405	41.57
.2	.8644	7.198	7.409	41.60
.3	.8639	7.193	7.415	41.63
.4	.8633	7.188	7.420	41.66
.5	.8628	7.184	7.424	41.68
.6	.8623	7.180	7.428	41.70
.7	.8618	7.176	7.432	41.73
.8	.8612	7.171	7.437	41.75
.9	.8607	7.167	7.442	41.78

A.P.I. Grav.	Spec. Grav.	Lbs. Per Gal.	Bbls. Per Ton	Cu. Ft. Per Ton
33.0	.8602	7.163	7.446	41.80
.1	.8597	7.158	7.451	41.83
.2	.8591	7.153	7.456	41.86
.3	.8586	7.149	7.460	41.88
.4	.8581	7.145	7.464	41.91
.5	.8576	7.141	7.469	41.93
.6	.8571	7.137	7.473	41.95
.7	.8565	7.132	7.478	41.98
.8	.8560	7.128	7.482	42.01
.9	.8555	7.123	7.487	42.03
34.0	.8550	7.119	7.492	42.06
.1	.8545	7.115	7.496	42.08
.2	.8540	7.111	7.500	42.11
.3	.8534	7.106	7.505	42.14
.4	.8529	7.102	7.510	42.16
.5	.8524	7.098	7.514	42.19
.6	.8519	7.093	7.519	42.21
.7	.8514	7.089	7.523	42.24
.8	.8509	7.085	7.528	42.26
.9	.8504	7.081	7.532	42.29
35.0	.8498	7.076	7.537	42.32
.1	.8493	7.072	7.541	42.34
.2	.8488	7.068	7.546	42.36
.3	.8483	7.063	7.551	42.39
.4	.8478	7.059	7.555	42.42
.5	.8473	7.055	7.560	42.44
.6	.8468	7.051	7.564	42.47
.7	.8463	7.047	7.568	42.49
.8	.8458	7.042	7.574	42.52
.9	.8453	7.038	7.578	42.55
36.0	.8448	7.034	7.582	42.57
.1	.8443	7.030	7.587	42.59
.2	.8438	7.026	7.591	42.62
.3	.8433	7.022	7.595	42.64
.4	.8428	7.018	7.600	42.66
.5	.8423	7.013	7.605	42.70
.6	.8418	7.009	7.609	42.72
.7	.8413	7.005	7.614	42.75
.8	.8408	7.001	7.618	42.77
.9	.8403	6.997	7.622	42.79
37.0	.8398	6.993	7.627	42.82
.1	.8393	6.989	7.632	42.84
.2	.8388	6.985	7.635	42.87
.3	.8383	6.980	7.641	42.90
.4	.8378	6.976	7.645	42.92
.5	.8373	6.972	7.650	42.95
.6	.8368	6.968	7.654	42.97
.7	.8363	6.964	7.658	42.99
.8	.8358	6.960	7.663	43.02
.9	.8353	6.955	7.668	43.05
38.0	.8348	6.951	7.673	43.08
.1	.8343	6.947	7.677	43.10
.2	.8338	6.943	7.682	43.12

A.P.I. Grav.	Spec. Grav.	Lbs. Per Gal.	Bbls. Per Ton	Cu. Ft. Per Ton
.3	.8333	6.939	7.686	43.15
.4	.8328	6.935	7.690	43.17
.5	.8324	6.930	7.696	43.21
.6	.8319	6.926	7.700	43.23
.7	.8314	6.922	7.705	43.26
.8	.8309	6.918	7.709	43.28
.9	.8304	6.914	7.714	43.31
39.0	.8299	6.910	7.718	43.33
.1	.8294	6.906	7.723	43.36
.2	.8289	6.902	7.727	43.38
.3	.8285	6.898	7.732	43.41
.4	.8280	6.894	7.736	43.43
.5	.8275	6.890	7.741	43.46
.6	.8270	6.886	7.745	43.48
.7	.8265	6.882	7.750	43.51
.8	.8260	6.878	7.754	43.53
.9	.8256	6.874	7.759	43.56
40.0	.8251	6.870	7.763	43.58
.1	.8246	6.866	7.768	43.61
.2	.8241	6.862	7.772	43.63
.3	.8236	6.858	7.777	43.66
.4	.8232	6.854	7.781	43.69
.5	.8227	6.850	7.786	43.71
.6	.8222	6.846	7.790	43.74
.7	.8217	6.842	7.795	43.76
.8	.8212	6.838	7.800	43.78
.9	.8208	6.834	7.804	43.81
41.0	.8203	6.830	7.809	43.84
.1	.8198	6.826	7.813	43.87
.2	.8193	6.822	7.818	43.89
.3	.8189	6.818	7.822	43.92
.4	.8184	6.814	7.827	43.94
.5	.8179	6.810	7.832	43.97
.6	.8174	6.806	7.836	43.99
.7	.8170	6.802	7.841	44.02
.8	.8165	6.798	7.845	44.04
.9	.8160	6.794	7.850	44.07
42.0	.8155	6.790	7.855	44.10
.1	.8151	6.786	7.859	44.12
.2	.8146	6.782	7.864	44.15
.3	.8142	6.779	7.867	44.17
.4	.8137	6.775	7.872	44.20
.5	.8132	6.771	7.877	44.22
.6	.8128	6.767	7.881	44.25
.7	.8123	6.763	7.886	44.27
.8	.8118	6.759	7.891	44.30
.9	.8114	6.756	7.894	44.32
43.0	.8109	6.752	7.899	44.35
.1	.8104	6.748	7.904	44.37
.2	.8100	6.744	7.908	44.40
.3	.8095	6.740	7.913	44.43
.4	.8090	6.736	7.918	44.45
.5	.8086	6.732	7.922	44.48
.6	.8081	6.728	7.927	44.51

A.P.I. Grav.	Spec. Grav.	Lbs. Per Gal.	Bbls. Per Ton	Cu. Ft. Per Ton
.7	.8076	6.724	7.932	44.53
.8	.8072	6.720	7.937	44.56
.9	.8067	6.716	7.941	44.58
44.0	.8063	6.713	7.945	44.61
.1	.8058	6.709	7.950	44.63
.2	.8054	6.705	7.954	44.66
.3	.8049	6.701	7.959	44.68
.4	.8044	6.697	7.964	44.71
.5	.8040	6.694	7.967	44.73
.6	.8035	6.690	7.972	44.76
.7	.8031	6.686	7.977	44.79
.8	.8026	6.682	7.982	44.81
.9	.8022	6.679	7.985	44.83
45.0	.8017	6.675	7.990	44.86
.1	.8012	6.671	7.995	44.89
.2	.8008	6.667	8.000	44.92
.3	.8003	6.663	8.004	44.94
.4	.7999	6.660	8.008	44.96
.5	.7994	6.656	8.013	44.99
.6	.7990	6.652	8.018	45.02
.7	.7985	6.648	8.022	45.04
.8	.7981	6.645	8.026	45.06
.9	.7976	6.641	8.031	45.09
46.0	.7972	6.637	8.036	45.12
.1	.7967	6.633	8.041	45.15
.2	.7963	6.630	8.044	45.16
.3	.7958	6.626	8.049	45.19
.4	.7954	6.622	8.054	45.22
.5	.7949	6.618	8.059	45.25
.6	.7945	6.615	8.062	45.26
.7	.7941	6.611	8.067	45.29
.8	.7936	6.607	8.072	45.32
.9	.7932	6.604	8.076	45.34
47.0	.7927	6.600	8.081	45.37
.1	.7923	6.596	8.086	45.40
.2	.7918	6.592	8.091	45.43
.3	.7914	6.589	8.094	45.44
.4	.7909	6.585	8.099	45.47
.5	.7905	6.582	8.103	45.49
.6	.7901	6.578	8.108	45.52
.7	.7896	6.574	8.113	45.55
.8	.7892	6.571	8.116	45.57
.9	.7887	6.567	8.121	45.59
48.0	.7883	6.563	8.126	45.62
.1	.7879	6.560	8.130	45.64
.2	.7874	6.556	8.135	45.67
.3	.7870	6.552	8.140	45.70
.4	.7865	6.548	8.145	45.73
.5	.7861	6.545	8.149	45.75
.6	.7857	6.541	8.154	45.78
.7	.7852	6.537	8.159	45.81
.8	.7848	6.534	8.162	45.83
.9	.7844	6.530	8.167	45.85

A.P.I. Grav.	Spec. Grav.	Lbs. Per Gal.	Bbls. Per Ton	Cu.Ft. Per Ton
49.0	.7839	6.526	8.172	45.88
.1	.7835	6.523	8.176	45.90
.2	.7831	6.520	8.180	45.93
.3	.7826	6.516	8.185	45.95
.4	.7822	6.512	8.190	45.98
.5	.7818	6.509	8.194	46.00
.6	.7813	6.505	8.199	46.03
.7	.7809	6.501	8.204	46.06
.8	.7805	6.498	8.208	46.08
.9	.7800	6.494	8.213	46.11
50.0	.7796	6.490	8.218	46.14
.1	.7792	6.487	8.222	46.16
.2	.7788	6.484	8.225	46.18
.3	.7783	6.480	8.230	46.21
.4	.7779	6.476	8.236	46.23
.5	.7775	6.473	8.239	46.26
.6	.7770	6.469	8.244	46.28
.7	.7766	6.466	8.248	46.31
.8	.7762	6.462	8.253	46.34
.9	.7758	6.459	8.257	46.36
51.0	.7753	6.455	8.262	46.39
.1	.7749	6.451	8.267	46.41
.2	.7745	6.448	8.271	46.44
.3	.7741	6.445	8.275	46.46
.4	.7736	6.441	8.280	46.49
.5	.7732	6.437	8.285	46.52
.6	.7728	6.434	8.289	46.54
.7	.7724	6.430	8.294	46.57
.8	.7720	6.427	8.298	46.59
.9	.7715	6.423	8.303	46.62
52.0	.7711	6.420	8.307	46.64
.1	.7707	6.416	8.313	46.67
.2	.7703	6.413	8.316	46.69
.3	.7699	6.410	8.320	46.71
.4	.7694	6.406	8.326	46.74
.5	.7690	6.402	8.331	46.77
.6	.7686	6.399	8.335	46.80
.7	.7682	6.396	8.339	46.82
.8	.7678	6.392	8.344	46.85
.9	.7674	6.389	8.348	46.87
53.0	.7669	6.385	8.353	46.90
.1	.7665	6.381	8.358	46.92
.2	.7661	6.378	8.362	46.95
.3	.7657	6.375	8.366	46.97
.4	.7653	6.371	8.371	47.00
.5	.7649	6.368	8.375	47.02
.6	.7645	6.365	8.379	47.04
.7	.7640	6.361	8.384	47.07
.8	.7636	6.357	8.390	47.10
.9	.7632	6.354	8.394	47.13
54.0	.7628	6.350	8.399	47.16
.1	.7624	6.347	8.403	47.18
.2	.7620	6.344	8.407	47.20

A.P.I. Grav.	Spec. Grav.	Lbs. Per Gal.	Bbls. Per Ton	Cu.Ft. Per Ton
.3	.7616	6.340	8.412	47.23
.4	.7612	6.337	8.416	47.25
.5	.7608	6.334	8.420	47.27
.6	.7603	6.330	8.425	47.30
.7	.7599	6.326	8.431	47.33
.8	.7595	6.323	8.435	47.36
.9	.7591	6.320	8.439	47.38
55.0	.7587	6.316	8.444	47.41
.1	.7583	6.313	8.448	47.43
.2	.7579	6.310	8.452	47.45
.3	.7575	6.306	8.458	47.48
.4	.7571	6.303	8.462	47.50
.5	.7567	6.300	8.466	47.53
.6	.7563	6.296	8.471	47.56
.7	.7559	6.293	8.475	47.58
.8	.7555	6.290	8.479	47.60
.9	.7551	6.287	8.483	47.63
56.0	.7547	6.283	8.489	47.65
.1	.7543	6.280	8.493	47.68
.2	.7539	6.276	8.498	47.71
.3	.7535	6.273	8.502	47.73
.4	.7531	6.270	8.506	47.76
.5	.7527	6.266	8.512	47.78
.6	.7523	6.263	8.516	47.81
.7	.7519	6.259	8.521	47.84
.8	.7515	6.256	8.525	47.86
.9	.7511	6.253	8.529	47.89
57.0	.7507	6.249	8.535	47.92
.1	.7503	6.246	8.539	47.94
.2	.7499	6.243	8.543	47.96
.3	.7495	6.240	8.547	47.99
.4	.7491	6.236	8.552	48.01
.5	.7487	6.233	8.557	48.04
.6	.7483	6.229	8.562	48.07
.7	.7479	6.226	8.566	48.09
.8	.7475	6.223	8.570	48.12
.9	.7471	6.219	8.576	48.15
58.0	.7467	6.216	8.580	48.17
.1	.7463	6.213	8.584	48.19
.2	.7459	6.209	8.590	48.23
.3	.7455	6.206	8.594	48.25
.4	.7451	6.203	8.598	48.27
.5	.7447	6.199	8.604	48.30
.6	.7443	6.196	8.608	48.33
.7	.7440	6.193	8.612	48.35
.8	.7436	6.190	8.616	48.37
.9	.7432	6.187	8.620	48.40
59.0	.7428	6.184	8.624	48.42
.1	.7424	6.180	8.630	48.45
.2	.7420	6.177	8.634	48.47
.3	.7416	6.174	8.638	48.50
.4	.7412	6.170	8.644	48.53
.5	.7408	6.167	8.648	48.55

A.P.I. Grav.	Spec. Grav.	Lbs. Per Gal.	Bbls. Per Ton	Cu.Ft. Per Ton
.6	.7405	6.164	8.652	48.58
.7	.7401	6.161	8.657	48.60
.8	.7397	6.158	8.661	48.63
.9	.7393	6.154	8.666	48.65
60.0	.7389	6.151	8.671	48.68
.1	.7385	6.148	8.675	48.70
.2	.7381	6.144	8.681	48.73
.3	.7377	6.141	8.685	48.76
.4	.7374	6.138	8.689	48.78
.5	.7370	6.135	8.693	48.81
.6	.7366	6.132	8.698	48.83
.7	.7362	6.129	8.702	48.86
.8	.7358	6.125	8.707	48.88
.9	.7354	6.122	8.712	48.91
61.0	.7351	6.119	8.716	48.93
.1	.7347	6.116	8.720	48.96
.2	.7343	6.113	8.725	48.98
.3	.7339	6.109	8.730	49.01
.4	.7335	6.106	8.735	49.04
.5	.7332	6.103	8.739	49.06
.6	.7328	6.100	8.743	49.09
.7	.7324	6.097	8.747	49.11
.8	.7320	6.094	8.752	49.14
.9	.7316	6.090	8.758	49.17
62.0	.7313	6.087	8.762	49.19
.1	.7309	6.084	8.766	49.22
.2	.7305	6.081	8.770	49.24
.3	.7301	6.078	8.775	49.27
.4	.7298	6.075	8.779	49.29
.5	.7294	6.072	8.783	49.31
.6	.7290	6.068	8.789	49.34
.7	.7286	6.065	8.794	49.37
.8	.7283	6.062	8.798	49.40
.9	.7279	6.059	8.802	49.42
63.0	.7275	6.056	8.807	49.45
.1	.7271	6.053	8.811	49.47
.2	.7268	6.050	8.815	49.49
.3	.7264	6.047	8.820	49.52
.4	.7260	6.044	8.824	49.54
.5	.7256	6.040	8.830	49.58
.6	.7253	6.037	8.834	49.60
.7	.7249	6.034	8.839	49.63
.8	.7245	6.031	8.843	49.65
.9	.7242	6.028	8.848	49.68
64.0	.7238	6.025	8.852	49.70
.1	.7234	6.022	8.856	49.72
.2	.7230	6.019	8.861	49.75
.3	.7227	6.016	8.865	49.77
.4	.7223	6.013	8.870	49.80
.5	.7219	6.010	8.874	49.82
.6	.7216	6.007	8.879	49.84
.7	.7212	6.004	8.883	49.87
.8	.7208	6.000	8.889	49.91
.9	.7205	5.997	8.893	49.93

A.P.I. Grav.	Spec. Grav.	Lbs. Per Gal.	Bbls. Per Ton	Cu.Ft. Per Ton
65.0	.7201	5.994	8.898	49.96
.1	.7197	5.991	8.902	49.98
.2	.7194	5.988	8.907	50.00
.3	.7190	5.985	8.911	50.03
.4	.7186	5.982	8.916	50.06
.5	.7183	5.979	8.920	50.08
.6	.7179	5.976	8.925	50.10
.7	.7175	5.973	8.929	50.13
.8	.7172	5.970	8.934	50.15
.9	.7168	5.967	8.938	50.18
66.0	.7165	5.964	8.943	50.20
.1	.7161	5.961	8.947	50.23
.2	.7157	5.958	8.952	50.25
.3	.7154	5.955	8.956	50.28
.4	.7150	5.952	8.961	50.30
.5	.7146	5.949	8.965	50.33
.6	.7143	5.946	8.970	50.36
.7	.7139	5.943	8.974	50.38
.8	.7136	5.940	8.979	50.41
.9	.7132	5.937	8.983	50.43
67.0	.7128	5.934	8.988	50.46
.1	.7125	5.931	8.992	50.48
.2	.7121	5.928	8.997	50.51
.3	.7118	5.925	9.001	50.54
.4	.7114	5.922	9.006	50.56
.5	.7111	5.919	9.011	50.59
.6	.7107	5.916	9.015	50.61
.7	.7103	5.913	9.020	50.64
.8	.7100	5.910	9.024	50.66
.9	.7096	5.907	9.029	50.69
68.0	.7093	5.904	9.033	50.71
.1	.7089	5.901	9.038	50.74
.2	.7086	5.898	9.043	50.77
.3	.7082	5.895	9.047	50.79
.4	.7079	5.892	9.052	50.82
.5	.7075	5.889	9.056	50.84
.6	.7071	5.886	9.061	50.87
.7	.7068	5.883	9.066	50.90
.8	.7064	5.880	9.070	50.92
.9	.7061	5.877	9.075	50.95
69.0	.7057	5.874	9.080	50.97
.1	.7054	5.871	9.084	51.00
.2	.7050	5.868	9.089	51.03
.3	.7047	5.866	9.092	51.05
.4	.7043	5.863	9.097	51.07
.5	.7040	5.860	9.101	51.10
.6	.7036	5.857	9.106	51.12
.7	.7033	5.854	9.111	51.15
.8	.7029	5.851	9.115	51.18
.9	.7026	5.848	9.120	51.20
70.0	.7022	5.845	9.125	51.23
.1	.7019	5.842	9.129	51.25
.2	.7015	5.839	9.134	51.28

A.P.I. Grav.	Spec. Grav.	Lbs. Per Gal.	Bbls. Per Ton	Cu.Ft. Per Ton
.3	.7012	5.836	9.139	51.31
.4	.7008	5.833	9.143	51.33
.5	.7005	5.831	9.147	51.35
.6	.7001	5.828	9.151	51.38
.7	.6998	5.825	9.156	51.41
.8	.6995	5.823	9.159	51.42
.9	.6991	5.820	9.164	51.45
71.0	.6988	5.817	9.169	51.47
.1	.6984	5.814	9.173	51.50
.2	.6981	5.811	9.178	51.53
.3	.6977	5.808	9.183	51.56
.4	.6974	5.805	9.187	51.58
.5	.6970	5.802	9.192	51.61
.6	.6967	5.799	9.197	51.64
.7	.6964	5.796	9.202	51.66
.8	.6960	6.793	9.207	51.69
.9	.6957	5.791	9.210	51.71
72.0	.6953	5.788	9.214	51.73
.1	.6950	5.785	9.219	51.76
.2	.6946	5.782	9.224	51.79
.3	.6943	5.779	9.229	51.82
.4	.6940	5.776	9.234	51.84
.5	.6936	5.773	9.238	51.87
.6	.6933	5.771	9.242	51.89
.7	.6929	5.768	9.246	51.91
.8	.6926	5.765	9.251	51.94
.9	.6923	5.762	9.256	51.97
73.0	.6919	5.759	9.261	51.99
.1	.6916	5.757	9.264	52.01
.2	.6913	5.754	9.269	52.04
.3	.6909	5.751	9.274	52.07
.4	.6906	5.748	9.279	52.09
.5	.6902	5.745	9.283	52.12
.6	.6899	5.743	9.287	52.14
.7	.6896	5.740	9.292	52.16
.8	.6892	5.737	9.296	52.19
.9	.6889	5.734	9.301	52.22
74.0	.6886	5.731	9.306	52.25
.1	.6882	5.728	9.311	52.28
.2	.6879	5.726	9.314	52.29
.3	.6876	5.723	9.319	52.32
.4	.6872	5.720	9.324	52.35
.5	.6869	5.718	9.327	52.37
.6	.6866	5.715	9.332	52.39
.7	.6862	5.712	9.337	52.42
.8	.6859	5.709	9.342	52.45
.9	.6856	5.706	9.347	52.48
75.0	.6852	5.703	9.352	52.51
.1	.6849	5.701	9.355	52.52
.2	.6846	5.698	9.360	52.55
.3	.6842	5.695	9.365	52.58
.4	.6839	5.693	9.368	52.60
.5	.6836	5.690	9.373	52.62
.6	.6832	5.687	9.378	52.65

A.P.I. Grav.	Spec. Grav.	Lbs. Per Gal.	Bbls. Per Ton	Cu.Ft. Per Ton
.7	.6829	5.685	9.381	52.67
.8	.6826	5.682	9.386	52.70
.9	.6823	5.679	9.391	52.72
76.0	.6819	5.676	9.396	52.75
.1	.6816	5.673	9.401	52.78
.2	.6813	5.671	9.405	52.80
.3	.6809	5.668	9.410	52.83
.4	.6806	5.665	9.415	52.85
.5	.6803	5.662	9.420	52.88
.6	.6800	5.660	9.423	52.90
.7	.6796	5.657	9.428	52.93
.8	.6793	5.654	9.433	52.96
.9	.6790	5.652	9.436	52.98
77.0	.6787	5.649	9.441	53.01
.1	.6783	5.646	9.446	53.03
.2	.6780	5.643	9.451	53.06
.3	.6777	5.641	9.455	53.08
.4	.6774	5.638	9.460	53.11
.5	.6770	5.635	9.465	53.14
.6	.6767	5.632	9.470	53.17
.7	.6764	5.630	9.473	53.19
.8	.6761	5.627	9.478	53.21
.9	.6757	5.624	9.483	53.24
78.0	.6754	5.622	9.487	53.26
.1	.6751	5.619	9.492	53.29
.2	.6748	5.617	9.495	53.31
.3	.6745	5.614	9.500	53.34
.4	.6741	5.611	9.505	53.36
.5	.6738	5.608	9.510	53.39
.6	.6735	5.606	9.514	53.42
.7	.6732	5.603	9.519	53.44
.8	.6728	5.600	9.524	53.47
.9	.6725	5.598	9.527	53.49
79.0	.6722	5.595	9.532	53.52
.1	.6719	5.592	9.537	53.54
.2	.6716	5.590	9.541	53.57
.3	.6713	5.587	9.546	53.60
.4	.6709	5.584	9.551	53.63
.5	.6706	5.582	9.555	53.65
.6	.6703	5.579	9.560	53.68
.7	.6700	5.577	9.563	53.70
.8	.6697	5.574	9.568	53.72
.9	.6693	5.571	9.573	53.74
80.0	.6690	5.568	9.579	53.78
.1	.6687	5.566	9.582	53.80
.2	.6684	5.563	9.587	53.83
.3	.6681	5.561	9.591	53.85
.4	.6678	5.558	9.596	53.88
.5	.6675	5.556	9.599	53.89
.6	.6671	5.553	9.604	53.92
.7	.6668	5.550	9.610	53.95
.8	.6665	5.548	9.613	53.97
.9	.6662	5.545	9.618	54.00
81.0	.6659	5.542	9.623	54.03
.1	.6656	5.540	9.627	54.05
.2	.6653	5.537	9.632	54.08

Group 6 (89.0 to 93.9° API)

t	M	t	M	t	M	t	M
0	1.0501	35	1.0211	65	0.9958	95	0.9702
1	1.0493	36	1.0203	66	.9949	96	.9693
2	1.0484	37	1.0194	67	.9941	97	.9685
3	1.0476	38	1.0186	68	.9932	98	.9676
4	1.0467	39	1.0177	69	.9924	99	.9668
5	1.0459	40	1.0169	70	.9915	100	.9659
6	1.0451	41	1.0160	71	.9907	101	.9650
7	1.0443	42	1.0152	72	.9898	102	.9642
8	1.0434	43	1.0143	73	.9890	103	.9633
9	1.0426	44	1.0135	74	.9881	104	.9625
10	1.0418	45	1.0126	75	.9873	105	.9616
11	1.0410	46	1.0118	76	.9864	106	.9608
12	1.0402	47	1.0110	77	.9856	107	.9599
13	1.0393	48	1.0101	78	.9847	108	.9590
14	1.0385	49	1.0093	79	.9839	109	.9582
15	1.0377	50	1.0084	80	.9830	110	.9573
16	1.0369	51	1.0076	81	.9821	111	.9565
17	1.0360	52	1.0067	82	.9813	112	.9556
18	1.0352	53	1.0059	83	.9804	113	.9548
19	1.0343	54	1.0050	84	.9796	114	.9539
20	1.0335	55	1.0042	85	.9787	115	.9530
21	1.0327	56	1.0034	86	.9779	116	.9522
22	1.0319	57	1.0025	87	.9770	117	.9513
23	1.0310	58	1.0017	88	.9762	118	.9505
24	1.0302	59	1.0008	89	.9753	119	.9496
25	1.0294	60	1.0000	90	.9745	120	.9487
26	1.0286	61	0.9992	91	.9736	121	.9479
27	1.0277	62	.9983	92	.9727	122	.9470
28	1.0269	63	.9975	93	.9719	123	.9462
29	1.0260	64	.9966	94	.9710	124	.9453
30	1.0252						
31	1.0244						
32	1.0236						
33	1.0227						
34	1.0219						

Group 5 (79.0 to 88.9° API)

t	M	t	M	t	M	t	M
0	1.0476	35	1.0200	65	0.9960	95	0.9717
1	1.0468	36	1.0192	66	.9952	96	.9709
2	1.0460	37	1.0184	67	.9944	97	.9700
3	1.0453	38	1.0176	68	.9935	98	.9692
4	1.0445	39	1.0168	69	.9927	99	.9684
5	1.0437	40	1.0160	70	.9919	100	.9676
6	1.0429	41	1.0152	71	.9911	101	.9668
7	1.0421	42	1.0144	72	.9903	102	.9660
8	1.0414	43	1.0136	73	.9895	103	.9652
9	1.0406	44	1.0128	74	.9887	104	.9643
10	1.0398	45	1.0120	75	.9879	105	.9635
11	1.0390	46	1.0112	76	.9871	106	.9627
12	1.0382	47	1.0104	77	.9863	107	.9619
13	1.0375	48	1.0096	78	.9854	108	.9611
14	1.0367	49	1.0088	79	.9846	109	.9603
15	1.0359	50	1.0080	80	.9838	110	.9594
16	1.0351	51	1.0072	81	.9830	111	.9586
17	1.0343	52	1.0064	82	.9822	112	.9578
18	1.0335	53	1.0056	83	.9814	113	.9570
19	1.0327	54	1.0048	84	.9806	114	.9562
20	1.0319	55	1.0040	85	.9798	115	.9554
21	1.0311	56	1.0032	86	.9790	116	.9546
22	1.0303	57	1.0024	87	.9782	117	.9538
23	1.0296	58	1.0016	88	.9773	118	.9529
24	1.0288	59	1.0008	89	.9765	119	.9521
25	1.0280	60	1.0000	90	.9757	120	.9513
26	1.0272	61	0.9992	91	.9749	121	.9505
27	1.0264	62	.9984	92	.9741	122	.9497
28	1.0256	63	.9976	93	.9733	123	.9489
29	1.0248	64	.9968	94	.9725	124	.9480
30	1.0240						
31	1.0232						
32	1.0224						
33	1.0216						
34	1.0208						

A.P.I. Grav.	Spec. Grav.	Lbs. Per Gal.	Bbls. Per Ton	Cu.Ft. Per Ton
.3	.6649	5.534	9.637	54.11
.4	.6646	5.532	9.641	54.13
.5	.6643	5.529	9.646	54.16
.6	.6640	5.526	9.651	54.18
.7	.6637	5.524	9.655	54.20
.8	.6634	5.522	9.658	54.22
.9	.6631	5.519	9.664	54.26
82.0	.6628	5.516	9.669	54.29
.1	.6625	5.514	9.672	54.30
.2	.6621	5.511	9.678	54.34
.3	.6618	5.508	9.683	54.36
.4	.6615	5.506	9.686	54.39
.5	.6612	5.503	9.692	54.41
.6	.6609	5.501	9.695	54.43
.7	.6606	5.498	9.700	54.46
.8	.6603	5.496	9.704	54.48
.9	.6600	5.493	9.709	54.51
83.0	.6597	5.491	9.713	54.53
.1	.6594	5.489	9.716	54.55
.2	.6591	5.486	9.722	54.58
.3	.6588	5.483	9.727	54.61
.4	.6584	5.480	9.732	54.64
.5	.6581	5.477	9.738	54.67
.6	.6578	5.475	9.741	54.69
.7	.6575	5.472	9.747	54.72
.8	.6572	5.470	9.750	54.74
.9	.6569	5.467	9.756	54.77
84.0	.6566	5.465	9.759	54.79
.1	.6563	5.462	9.764	54.82
.2	.6560	5.460	9.768	54.84
.3	.6557	5.458	9.772	54.86
.4	.6554	5.455	9.777	54.89
.5	.6551	5.453	9.781	54.91
.6	.6548	5.450	9.786	54.94
.7	.6545	5.448	9.790	54.96
.8	.6542	5.445	9.795	54.99
.9	.6539	5.443	9.799	55.02
85.0	.6536	5.440	9.804	55.04
.1	.6533	5.437	9.809	55.07
.2	.6530	5.435	9.813	55.09
.3	.6527	5.432	9.818	55.12
.4	.6524	5.430	9.822	55.14
.5	.6521	5.427	9.827	55.17
.6	.6518	5.425	9.831	55.20
.7	.6515	5.422	9.836	55.22
.8	.6512	5.420	9.840	55.25
.9	.6509	5.417	9.846	55.28
86.0	.6506	5.415	9.849	55.30
.1	.6503	5.412	9.855	55.33
.2	.6500	5.410	9.858	55.35
.3	.6497	5.407	9.864	55.38
.4	.6494	5.405	9.867	55.40
.5	.6491	5.402	9.873	55.42
.6	.6488	5.400	9.877	55.45
.7	.6485	5.397	9.882	55.48
.8	.6482	5.395	9.886	55.50
.9	.6479	5.392	9.891	55.53

A.P.I. Grav.	Spec. Grav.	Lbs. Per Gal.	Bbls. Per Ton	Cu.Ft. Per Ton
87.0	.6476	5.390	9.895	55.55
.1	.6473	5.387	9.900	55.58
.2	.6470	5.385	9.904	55.61
.3	.6467	5.382	9.910	55.64
.4	.6464	5.380	9.913	55.66
.5	.6461	5.377	9.919	55.69
.6	.6458	5.375	9.922	55.71
.7	.6455	5.372	9.928	55.74
.8	.6452	5.370	9.932	55.76
.9	.6449	5.367	9.937	55.79
88.0	.6446	5.365	9.941	55.81
.1	.6444	5.363	9.945	55.84
.2	.6441	5.361	9.948	55.85
.3	.6438	5.358	9.954	55.89
.4	.6435	5.356	9.958	55.91
.5	.6432	5.353	9.963	55.94
.6	.6429	5.351	9.967	55.96
.7	.6426	5.348	9.973	55.99
.8	.6423	5.346	9.976	56.01
.9	.6420	5.343	9.982	56.04
89.0	.6417	5.341	9.986	56.07
.1	.6414	5.338	9.991	56.09
.2	.6411	5.336	9.995	56.12
.3	.6409	5.334	9.999	56.14
.4	.6406	5.331	10.004	56.17
.5	.6403	5.329	10.008	56.19
.6	.6400	5.326	10.014	56.22
.7	.6397	5.324	10.018	56.24
.8	.6394	5.321	10.023	56.27
.9	.6391	5.319	10.027	56.30
90.0	.6388	5.316	10.033	56.33
.1	.6385	5.314	10.036	56.35
.2	.6382	5.312	10.040	56.37
.3	.6380	5.310	10.044	56.39
.4	.6377	5.307	10.050	56.43
.5	.6374	5.305	10.053	56.44
.6	.6371	5.302	10.059	56.48
.7	.6368	5.300	10.063	56.50
.8	.6365	5.297	10.069	56.53
.9	.6362	5.295	10.072	56.55
91.0	.6360	5.293	10.076	56.57
.1	.6357	5.291	10.080	56.59
.2	.6354	5.288	10.086	56.63
.3	.6351	5.286	10.090	56.65
.4	.6348	5.283	10.095	56.68
.5	.6345	5.281	10.099	56.70
.6	.6342	5.278	10.105	56.74
.7	.6340	5.276	10.109	56.76
.8	.6337	5.274	10.113	56.78
.9	.6334	5.271	10.118	56.81
92.0	.6331	5.269	10.122	56.83
.1	.6328	5.266	10.128	56.86
.2	.6325	5.264	10.132	56.89
.3	.6323	5.262	10.136	56.91
.4	.6320	5.260	10.139	56.93
,5	.6317	5.257	10.145	56.96
.6	.6314	5.254	10.151	56.99
.7	.6311	5.252	10.155	57.02

A.P.I. Grav.	Spec. Grav.	Lbs. Per Gal.	Bbls. Per Ton	Cu.Ft. Per Ton.
.8	.6309	5.250	10.159	57.04
.9	.6306	5.248	10.163	57.06
93.0	.6303	5.246	10.166	57.08
.1	.6300	5.243	10.172	57.11
.2	.6297	5.240	10.178	57.15
.3	.6294	5.238	10.182	57.17
.4	.6292	5.236	10.186	57.19
.5	.6289	5.234	10.190	57.21
.6	.6286	5.232	10.194	57.24
.7	.6283	5.229	10.200	57.27
.8	.6281	5.227	10.203	57.29
.9	.6278	5.225	10.207	57.31

Fahr.	Cent.	Fahr.	Cent.	Fahr.	Cent.	Fahr.	Cent.
-40	-40.0	18	- 7.8	76	24.4	134	56.7
-39	-39.4	19	- 7.2	77	25.0	135	57.2
-38	-38.9	20	- 6.7	78	25.6	136	57.8
-37	-38.3	21	- 6.1	79	26.1	137	58.3
-36	-37.8	22	- 5.6	80	26.7	138	58.9
-35	-37.2	23	- 5.0	81	27.2	139	59.4
-34	-36.7	24	- 4.4	82	27.8	140	60.0
-33	-36.1	25	- 3.9	83	28.3	141	60.6
-32	-35.6	26	- 3.3	84	28.9	142	61.1
-31	-35.0	27	- 2.8	85	29.4	143	61.7
-30	-34.4	28	- 2.2	86	30.0	144	62.2
-29	-33.9	29	- 1.7	87	30.6	145	62.8
-28	-33.3	30	- 1.1	88	31.1	146	63.3
-27	-32.8	31	- 0.6	89	31.7	147	63.9
-26	-32.2	32	0.0	90	32.2	148	64.4
-25	-31.7	33	0.6	91	32.8	149	65.0
-24	-31.1	34	1.1	92	33.3	150	65.6
-23	-30.6	35	1.7	93	33.9	151	66.1
-22	-30.0	36	2.2	94	34.4	152	66.7
-21	-29.4	37	2.8	95	35.0	153	67.2
-20	-28.9	38	3.3	96	35.6	154	67.8
-19	-28.3	39	3.9	97	36.1	155	68.3
-18	-27.8	40	4.4	98	36.7	156	68.9
-17	-27.2	41	5.0	99	37.2	157	69.4
-16	-26.7	42	5.6	100	37.8	158	70.0
-15	-26.1	43	6.1	101	38.3	159	70.6
-14	-25.6	44	6.7	102	38.9	160	71.1
-13	-25.0	45	7.2	103	39.4	161	71.7
-12	-24.4	46	7.8	104	40.0	162	72.2
-11	-23.9	47	8.3	105	40.6	163	72.8
-10	-23.3	48	8.9	106	41.1	164	73.3
- 9	-22.8	49	9.4	107	41.7	165	73.9
- 8	-22.2	50	10.0	108	42.2	166	74.4
- 7	-21.7	51	10.6	109	42.8	167	75.0
- 6	-21.1	52	11.1	110	43.3	168	75.6
- 5	-20.6	53	11.7	111	43.9	169	76.1
- 4	-20.0	54	12.2	112	44.4	170	76.7
- 3	-19.4	55	12.8	113	45.0	171	77.2
- 2	-18.9	56	13.3	114	45.6	172	77.8
- 1	-18.3	57	13.9	115	46.1	173	78.3
0	-17.8	58	14.4	116	46.7	174	78.9
1	-17.2	59	15.0	117	47.2	175	79.4
2	-16.7	60	15.6	118	47.8	176	80.0
3	-16.1	61	16.1	119	48.3	177	80.6
4	-15.6	62	16.7	120	48.9	178	81.1
5	-15.0	63	17.2	121	49.4	179	81.7
6	-14.4	64	17.8	122	50.0	180	82.2
7	-13.9	65	18.3	123	50.6	181	82.8
8	-13.3	66	18.9	124	51.1	182	83.3
9	-12.8	67	19.4	125	51.7	183	83.9
10	-12.2	68	20.0	126	52.2	184	84.4
11	-11.7	69	20.6	127	52.8	185	85.0
12	-11.1	70	21.1	128	53.3	186	85.6
13	-10.6	71	21.7	129	53.9	187	86.1
14	-10.0	72	22.2	130	54.4	188	86.7
15	- 9.4	73	22.8	131	55.0	189	87.2
16	- 8.9	74	23.3	132	55.6	190	87.8
17	- 8.3	75	23.9	133	56.1	191	88.3

Fahr.	Cent.	Fahr.	Cent	Fahr.	Cent.	Fahr.	Cent.
192	88.9	247	119.4	302	150.0	357	180.6
193	89.4	248	120.0	303	150.6	358	181.1
194	90.0	249	120.6	304	151.1	359	181.7
195	90.6	250	121.1	305	151.7	360	182.2
196	91.1	251	121.7	306	152.2	361	182.8
197	91.7	252	122.2	307	152.8	362	183.3
198	92.2	253	122.8	308	153.3	363	183.9
199	92.8	254	123.3	309	153.9	364	184.4
200	93.3	255	123.9	310	154.4	365	185.0
201	93.9	256	124.4	311	155.0	366	185.6
202	94.4	257	125.0	312	155.6	367	186.1
203	95.0	258	125.6	313	156.1	368	186.7
204	95.6	259	126.1	314	156.7	369	187.2
205	96.1	260	126.7	315	157.2	370	187.8
206	96.7	261	127.2	316	157.8	371	188.3
207	97.2	262	127.8	317	158.3	372	188.9
208	97.8	263	128.3	318	158.9	373	189.4
209	98.3	264	128.9	319	159.4	374	190.0
210	98.9	265	129.4	320	160.0	375	190.6
211	99.4	266	130.0	321	160.6	376	191.1
212	100.0	267	130.6	322	161.1	377	191.7
213	100.6	268	131.1	323	161.7	378	192.2
214	101.1	269	131.7	324	162.2	379	192.8
215	101.7	270	132.2	325	162.8	380	193.3
216	102.2	271	132.8	326	163.3	381	193.9
217	102.8	272	133.3	327	163.9	382	194.4
218	103.3	273	133.9	328	164.4	383	195.0
219	103.9	274	134.4	329	165.0	384	195.6
220	104.4	275	135.0	330	165.6	385	196.1
221	105.0	276	135.6	331	166.1	386	196.7
222	105.6	277	136.1	332	166.7	387	197.2
223	106.1	278	136.7	333	167.2	388	197.8
224	106.7	279	137.2	334	167.8	389	198.3
225	107.2	280	137.8	335	168.3	390	198.9
226	107.8	281	138.3	336	168.9	391	199.4
227	108.3	282	138.9	337	169.4	392	200.0
228	108.9	283	139.4	338	170.0	393	200.6
229	109.4	284	140.0	339	170.6	394	201.1
230	110.0	285	140.6	340	171.1	395	201.7
231	110.6	286	141.1	341	171.7	396	202.2
232	111.1	287	141.7	342	172.2	397	202.8
233	111.7	288	142.2	343	172.8	398	203.3
234	112.2	289	142.8	344	173.3	399	203.9
235	112.8	290	143.3	345	173.9	400	204.4
236	113.3	291	143.9	346	174.4	401	205.0
237	113.9	292	144.4	347	175.0	402	205.6
238	114.4	293	145.0	348	175.6	403	206.1
239	115.0	294	145.6	349	176.1	404	206.7
240	115.6	295	146.1	350	176.7	405	207.2
241	116.1	296	146.7	351	177.2	406	207.8
242	116.7	297	147.2	352	177.8	407	208.3
243	117.2	298	147.8	353	178.3	408	208.9
244	117.8	299	148.3	354	178.9	409	209.4
245	118.3	300	148.9	355	179.4	410	210.0
246	118.9	301	149.4	356	180.0	411	210.6

Fahr.	Cent.	Fahr.	Cent.	Fahr.	Cent.	Fahr.	Cent.
412	211.1	467	241.7	522	272.2	577	302.8
413	211.7	468	242.2	523	272.8	578	303.3
414	212.2	469	242.8	524	273.3	579	303.9
415	212.8	470	243.3	525	273.9	580	304.4
416	213.3	471	243.9	526	274.4	581	305.0
417	213.9	472	244.4	527	275.0	582	305.6
418	214.4	473	245.0	528	275.6	583	306.1
419	215.0	474	245.6	529	276.1	584	306.7
420	215.6	475	246.1	530	276.7	585	307.2
421	216.1	476	246.7	531	277.2	586	307.8
422	216.7	477	247.2	532	277.8	587	308.3
423	217.2	478	247.8	533	278.3	588	308.9
424	217.8	479	248.3	534	278.9	589	309.4
425	218.3	480	248.9	535	279.4	590	310.0
426	218.9	481	249.4	536	280.0	591	310.6
427	219.4	482	250.0	537	280.6	592	311.1
428	220.0	483	250.6	538	281.1	593	311.7
429	220.6	484	251.1	539	281.7	594	312.2
430	221.1	485	251.7	540	282.2	595	312.8
431	221.7	486	252.2	541	282.8	596	313.3
432	222.2	487	252.8	542	283.3	597	313.9
433	222.8	488	253.3	543	283.9	598	314.4
434	223.3	489	253.9	544	284.4	599	315.0
435	223.9	490	254.4	545	285.0	600	315.6
436	224.4	491	255.0	546	285.6	601	316.1
437	225.0	492	255.6	547	286.1	602	316.7
438	225.6	493	256.1	548	286.7	603	317.2
439	226.1	494	256.7	549	287.2	604	317.8
440	226.7	495	257.2	550	287.8	605	318.3
441	227.2	496	257.8	551	288.3	606	318.9
442	227.8	497	258.3	552	288.9	607	319.4
443	228.3	498	258.9	553	289.4	608	320.0
444	228.9	499	259.4	554	290.0	609	320.6
445	229.4	500	260.0	555	290.6	610	321.1
446	230.0	501	260.6	556	291.1	611	321.7
447	230.6	502	261.1	557	291.7	612	322.2
448	231.1	503	261.7	558	292.2	613	322.8
449	231.7	504	262.2	559	292.8	614	323.3
450	232.2	505	262.8	560	293.3	615	323.9
451	232.8	506	263.3	561	293.9	616	324.4
452	233.3	507	263.9	562	294.4	617	325.0
453	233.9	508	264.4	563	295.0	618	325.6
454	234.4	509	265.0	564	295.6	619	326.1
455	235.0	510	265.6	565	296.1	620	326.7
456	235.6	511	266.1	566	296.7	621	327.2
457	236.1	512	266.7	567	297.2	622	327.8
458	236.7	513	267.2	568	297.8	623	328.3
459	237.2	514	267.8	569	298.3	624	328.9
460	237.8	515	268.3	570	298.9	625	329.4
461	238.3	516	268.9	571	299.4	626	330.0
462	238.9	517	269.4	572	300.0	627	330.6
463	239.4	518	270.0	573	300.6	628	331.1
464	240.0	519	270.6	574	301.1	629	331.7
465	240.6	520	271.1	575	301.7	630	332.2
466	241.1	521	271.7	576	302.2	631	332.8

Fahr.	Cent.	Fahr.	Cent.	Fahr.	Cent.	Fahr.	Cent.
632	333.3	643	339.4	654	345.6	665	351.7
633	333.9	644	340.0	655	346.1	666	352.2
634	334.4	645	340.6	656	346.7	667	352.8
635	335.0	646	341.1	657	347.2	668	353.3
636	335.6	647	341.7	658	347.8	669	353.9
637	336.1	648	342.2	659	348.3	670	354.4
638	336.7	649	342.8	660	348.9	671	355.0
639	337.2	650	343.3	661	349.4	672	355.6
640	337.8	651	343.9	662	350.0	673	356.1
641	338.3	652	344.4	663	350.6	674	356.7
642	338.9	653	345.0	664	351.1	675	357.2

ABRIDGED VOLUME CORRECTION TABLE FOR PETROLEUM OILS

SUPPLEMENT TO NBS CIRCULAR C410
(Issued April 20, 1937)
Supersedes Supplements to Circular 154

(Approved by American Petroleum Institute, American Society for Testing Materials, U.S. Bureau of Mines, and National Bureau of Standards. For complete table, see table 2, NBS Circular C410)

The table of reduction factors contained herein has been prepared to meet a demand from the oil industry for a short and convenient table for reducing oil volumes to the basis of 60° F when extreme accuracy is not required. It is not intended to replace the more complete volume correction table contained in Circular C410, but rather to supplement it and especially to replace the various abridged tables heretofore employed in the oil industry.

The groups, coefficients of expansion, degrees API, and gravity ranges for the several subdivisions of the present abridged table are:

Group number	Coefficient of expansion at 60°F	Corresponding degrees API	Range of group (degrees API at 60 F)
0.............	0.00035	6	Up to 14.9
1.............	.00040	22	15.0 to 34.9
2.............	.00050	44	35.0 to 50.9
3.............	.00060	58	51.0 to 63.9
4.............	.00070	72	64.0 to 78.9
5.............	.00080	86	79.0 to 88.9
6.............	.00085	91	89.0 to 93.9
7.............	.00090	97	94.0 to 99.9

All motor fuel blends of gasoline and benzol shall be considered as falling in Group 3. In cases of uncertainty regarding the presence of benzol, a product having a gravity heavier (numerically less) than 51 deg. A.P.I., and a 50% recovery point less than 293 F. (145 C.) shall be considered as falling in Group 3.

This table shows the volume occupied at 60 F. by a quantity of oil occupying unit volume at the indicated temperatures.

This abridged table differs from that published in Revised Supplement to NBS Circular C154 issued in 1934 in three respects:
The multipliers for group 0 have been revised slightly; group 1 has been extended from 249 to 499°F; and groups 4, 5, and 6 have been extended from 99 to 124°F.

The multipliers in the group 0 table in the Revised Supplement to NBS Circular C154 issued in 1934 were taken from the National Bureau of Standards Miscellaneous Publication M97. With the revision of Circular C154 (published as Circular C410) to include data on oils from 0 to 10°API, it has seemed desirable to employ the procedure followed in the other groups and choose the column of multipliers from the unabridged table which has a base coefficient of expansion nearest 0.00035, which, in the case of group 0, is the column corresponding to a gravity of 6° of API.

Group 0 (up to 14.9° API)

t	M	t	M	t	M	t	M
0	1.0211	45	1.0052	90	0.9896	135	0.9741
1	1.0208	46	1.0049	91	.9892	136	.9738
2	1.0204	47	1.0045	92	.9889	137	.9735
3	1.0201	48	1.0042	93	.9886	138	.9731
4	1.0197	49	1.0039	94	..9882	139	.9728
5	1.0194	50	1.0035	95	.9879	140	.9724
6	1.0190	51	1.0032	96	.9876	141	.9721
7	1.0186	52	1.0028	97	.9872	142	.9718
8	1.0183	53	1.0025	98	.9869	143	.9714
9	1.0179	54	1.0021	99	.9865	144	.9711
10	1.0176	55	1.0017	100	.9862	145	.9707
11	1.0172	56	1.0014	101	.9858	146	.9704
12	1.0168	57	1.0010	102	.9855	147	.9701
13	1.0165	58	1.0007	103	.9852	148	.9697
14	1.0161	59	1.0003	104	.9848	149	.9694
15	1.0158	60	1.0000	105	.9844	150	.9691
16	1.0154	61	0.9997	106	.9841	151	.9687
17	1.0151	62	.9993	107	.9837	152	.9684
18	1.0147	63	.9990	108	.9834	153	.9680
19	1.0144	64	.9986	109	.9831	154	.9677
20	1.0141	65	.9982	110	.9827	155	.9674
21	1.0137	66	.9979	111	.9823	156	.9670
22	1.0134	67	.9976	112	.9820	157	.9667
23	1.0130	68	.9972	113	.9816	158	.9664
24	1.0126	69	.9969	114	.9813	159	.9660
25	1.0123	70	.9965	115	.9809	160	.9657
26	1.0119	71	.9962	116	.9806	161	.9654
27	1.0116	72	.9958	117	.9802	162	.9650
28	1.0112	73	.9955	118	.9799	163	.9647
29	1.0109	74	.9952	119	.9795	164	.9643
30	1.0106	75	.9948	120	.9792	165	.9640
31	1.0102	76	.9944	121	.9789	166	.9637
32	1.0098	77	.9941	122	.9785	167	.9633
33	1.0095	78	.9938	123	.9782	168	.9630
34	1.0092	79	.9934	124	.9779	169	.9627
35	1.0088	80	.9931	125	.9775	170	.9623
36	1.0084	81	.9927	126	.9772	171	.9620
37	1.0081	82	.9924	127	.9768	172	.9616
38	1.0077	83	.9920	128	.9765	173	.9613
39	1.0074	84	.9917	129	.9762	174	.9610
40	1.0070	85	.9914	130	.9758	175	.9606
41	1.0067	86	.9910	131	.9755	176	.9603
42	1.0063	87	.9907	132	.9751	177	.9600
43	1.0059	88	.9903	133	.9748	178	.9596
44	1.0056	89	.9900	134	.9745	179	.9593

Group 0 (up to 14.9° API)

t	M	t	M	t	M	t	M
180	0.9590	225	0.9441	270	0.9296	315	0.9154
181	.9586	226	.9438	271	.9293	316	.9151
182	.9583	227	.9435	272	.9290	317	.9148
183	.9580	228	.9432	273	.9287	318	.9145
184	.9576	229	.9428	274	.9283	319	.9141
185	.9573	230	.9425	275	.9280	320	.9138
186	.9569	231	.9422	276	.9277	321	.9135
187	.9566	232	.9419	277	.9274	322	.9132
188	.9563	233	.9415	278	.9271	323	.9129
189	.9559	234	.9412	279	.9267	324	.9126
190	.9556	235	.9409	280	.9264	325	.9123
191	.9553	236	.9406	281	.9261	326	.9119
192	.9549	237	.9402	282	.9258	327	.9116
193	.9546	238	.9399	283	.9255	328	.9113
194	.9543	239	.9396	284	.9252	329	.9110
195	.9539	240	.9392	285	.9248	330	.9107
196	.9536	241	.9389	286	.9245	331	.9104
197	.9533	242	.9386	287	.9242	332	.9101
198	.9530	243	.9383	288	.9239	333	.9098
199	.9527	244	.9380	289	.9236	334	.9095
200	.9523	245	.9376	290	.9233	335	.9092
201	.9520	246	.9373	291	.9229	336	.9088
202	.9517	247	.9370	292	.9226	337	.9085
203	.9513	248	.9367	293	.9223	338	.9082
204	.9510	249	.9364	294	.9220	339	.9079
205	.9507	250	.9360	295	.9217	340	.9076
206	.9504	251	.9357	296	.9214	341	.9073
207	.9500	252	.9354	297	.9210	342	.9070
208	.9497	253	.9351	298	.9207	343	.9067
209	.9494	254	.9347	299	.9204	344	.9064
210	.9490	255	.9344	300	.9201	345	.9061
211	.9487	256	.9341	301	.9198	346	.9057
212	.9484	257	.9338	302	.9195	347	.9054
213	.9481	258	.9335	303	.9191	348	.9051
214	.9477	259	.9331	304	.9188	349	.9048
215	.9474	260	.9328	305	.9185	350	.9045
216	.9471	261	.9325	306	.9182	351	.9042
217	.9468	262	.9322	307	.9179	352	.9039
218	.9464	263	.9319	308	.9176	353	.9036
219	.9461	264	.9315	309	.9173	354	.9033
220	.9458	265	.9312	310	.9169	355	.9030
221	.9454	266	.9309	311	.9166	356	.9027
222	.9451	267	.9306	312	.9163	357	.9024
223	.9448	268	.9303	313	.9160	358	.9021
224	.9445	269	.9299	314	.9157	359	.9017

Group 0 (up to 14.9° API)

t	M	t	M	t	M	t	M
360	0.9014	395	0.8908	430	0.8803	465	0.8700
361	.9011	396	.8905	431	.8800	466	.8697
362	.9008	397	.8902	432	.8797	467	.8694
363	.9005	398	.8899	433	.8794	468	.8691
364	.9002	399	.8896	434	.8791	469	.8688
365	.8999	400	.8893	435	.8788	470	.8685
366	.8996	401	.8890	436	.8785	471	.8682
367	.8993	402	.8887	437	.8782	472	.8679
368	.8990	403	.8884	438	.8779	473	.8676
369	.8987	404	.8881	439	.8776	474	.8673
370	.8984	405	.8878	440	.8773	475	.8671
371	.8981	406	.8875	441	.8770	476	.8668
372	.8978	407	.8872	442	.8767	477	.8665
373	.8975	408	.8869	443	.8764	478	.8862
374	.8972	409	.8866	444	.8762	479	.8659
375	.8969	410	.8865	445	.8759	480	.8656
376	.8965	411	.8860	446	.8756	481	.8653
377	.8962	412	.8857	447	.8753	482	.8650
378	.8959	413	.8854	448	.8750	483	.8647
379	.8956	414	.8851	449	.8747	484	.8644
380	.8953	415	.8848	450	.8744	485	.8642
381	.8950	416	.8845	451	.8741	486	.8639
382	.8947	417	.8842	452	.8738	487	.8636
383	.8944	418	.8839	453	.8735	488	.8633
384	.8941	419	.8836	454	.8732	489	.8630
385	.8938	420	.8833	455	.8729	490	.8627
386	.8955	421	.8830	456	.8726	491	.8624
387	.8932	422	.8827	457	.8723	492	.8621
388	.8929	423	.8824	458	.8720	493	.8618
389	.8926	424	.8821	459	.8717	494	.8615
390	.8923	425	.8818	460	.8714	495	.8613
391	.8920	426	.8815	461	.8711	496	.8610
392	.8917	427	.8812	462	.8709	497	.8607
393	.8914	428	.8809	463	.8706	498	.8604
394	.8911	429	.8806	464	.8703	499	.8601

Group 1 (15.0 to 34.9° API)

t	M	t	M	t	M	t	M
0	1.0242	45	1.0060	90	0.9881	135	0.9705
1	1.0238	46	1.0056	91	.9877	136	.9701
2	1.0234	47	1.0052	92	.9873	137	.9697
3	1.0230	48	1.0048	93	.9869	138	.9694
4	1.0226	49	1.0044	94	.9865	139	.9690
5	1.0222	50	1.0040	95	.9861	140	.9686
6	1.0218	51	1.0036	96	.9857	141	.9682
7	1.0214	52	1.0032	97	.9853	142	.9678
8	1.0210	53	1.0028	98	.9849	143	.9675
9	1.0206	54	1.0024	99	.9845	144	.9671
10	1.0202	55	1.0020	100	.9841	145	.9667
11	1.0198	56	1.0016	101	.9837	146	.9663
12	1.0194	57	1.0012	102	.9833	147	.9659
13	1.0189	58	1.0008	103	.9830	148	.9655
14	1.0185	59	1.0004	104	.9826	149	.9651
15	1.0181	60	1.0000	105	.9822	150	.9647
16	1.0177	61	0.9996	106	.9818	151	.9643
17	1.0173	62	.9992	107	.9814	152	.9639
18	1.0169	63	.9988	108	.9811	153	.9636
19	1.0165	64	.9984	109	.9807	154	.9632
20	1.0161	65	.9980	110	.9803	155	.9628
21	1.0157	66	.9976	111	.9799	156	.9624
22	1.0153	67	.9972	112	.9795	157	.9620
23	1.0148	68	.9968	113	.9791	158	.9616
24	1.0144	69	.9964	114	.9787	159	.9612
25	1.0140	70	.9940	115	.9783	.60	.9608
26	1.0136	71	.9956	116	.9779	161	.9604
27	1.0132	72	.9952	117	.9775	162	.9601
28	1.0128	73	.9948	118	.9771	163	.9597
29	1.0124	74	.9944	119	.9767	164	.9594
30	1.0120	75	.9940	120	.9763	165	.9590
31	1.0116	76	.9936	121	.9759	166	.9586
32	1.0112	77	.9932	122	.9755	167	.9582
33	1.0108	78	.9929	123	.9752	168	.9578
34	1.0104	79	.9925	124	.9748	169	.9574
35	1.0100	80	.9921	125	.9744	170	.9570
36	1.0096	81	.9917	126	.9740	171	.9566
37	1.0092	82	.9913	127	.9736	172	.9562
38	1.0088	83	.9909	128	.9732	173	.9552
39	1.0084	84	.9905	129	.9728	174	.9555
40	1.0080	85	.9901	130	.9724	175	.9551
41	1.0076	86	.9897	131	.9720	176	.8547
42	1.0072	87	.9893	132	.9716	177	.9543
43	1.0068	88	.9889	133	.9713	178	.9540
44	1.0064	89	.9885	134	.9709	179	.9536

Group 1 (15.0 to 34.9° API)

t	M	t	M	t	M	t	M
180	0.9532	225	0.9363	270	0.9197	315	0.9034
181	.9528	226	.9359	271	.9193	316	.9030
182	.9524	227	.9356	272	.9190	317	.9027
183	.9521	228	.9352	273	.9186	318	.9023
184	.9517	229	.9349	274	.9182	319	.9020
185	.9513	230	.9345	275	.9179	320	.9016
186	.9509	231	.9341	276	.9175	321	.9012
187	.9505	232	.9337	277	.9171	322	.9009
188	.9502	233	.9334	278	.9168	323	.9005
189	.9498	234	.9330	279	.9164	324	.9002
190	.9494	235	.9326	280	.9160	325	.8998
191	.9490	236	.9322	281	.9157	326	.8994
192	.9487	237	.9318	282	.9153	327	.8991
193	.9483	238	.9315	283	.9149	328	.8987
194	.9480	239	.9311	284	.9146	329	.8984
195	.9476	240	.9307	285	.9142	330	.8980
196	.9472	241	.9303	286	.9139	331	.8977
197	.9468	242	.9300	287	.9135	332	.8973
198	.9465	243	.9296	288	.9131	333	.8969
199	.9461	244	.9293	289	.9128	334	.8966
200	.9457	245	.9289	290	.9124	335	.8962
201	.9453	246	.9285	291	.9120	336	.8959
202	.9449	247	.9281	292	.9117	337	.8955
203	.9446	248	.9278	293	.9113	338	.8952
204	.9442	249	.9274	294	.9110	339	.8948
205	.9438	250	.9270	295	.9106	340	.8945
206	.9434	251	.9267	296	.9102	341	.8941
207	.9430	252	.9263	297	.9099	342	.8938
208	.9427	253	.9259	298	.9095	343	.8934
209	.9423	254	.9256	299	.9091	344	.8930
210	.9419	255	.9252	300	.9088	345	.8927
211	.9415	256	.9248	301	.9084	346	.8923
212	.9412	257	.9245	302	.9081	347	.8920
213	.9408	258	.9241	303	.9077	348	.8916
214	.9405	259	.9237	304	.9073	349	.8913
215	.9401	260	.9234	305	.9070	350	.8909
216	.9397	261	.9230	306	.9066	351	.8906
217	.9393	262	.9226	307	.9063	352	.8902
218	.9390	263	.9223	308	.9059	353	.8899
219	.9386	264	.9219	309	.9055	354	.8895
220	.9382	265	.9215	310	.9052	355	.8892
221	.9378	266	.9212	311	.9048	356	.8888
222	.9374	267	.9208	312	.9045	357	.8884
223	.9371	268	.9204	313	.9041	358	.8881
224	.9367	269	.9201	314	.9037	359	.8877

Group 1 (15.0 to 34.9° API)

t	M	t	M	t	M	t	M
360	0.8874	395	0.8752	430	0.8631	465	0.8513
361	.8870	396	.8748	431	.8628	466	.8509
362	.8867	397	.8745	432	.8624	467	.8506
363	.8863	398	.8741	433	.8621	468	.8503
364	.8860	399	.8738	434	.8618	469	.8499
365	.8856	400	.8734	435	.8614	470	.8496
366	.8853	401	.8731	436	.8611	471	.8493
367	.8849	402	.8727	437	.8607	472	.8489
368	.8846	403	.8724	438	.8604	473	.8486
369	.8842	404	.8720	439	.8601	474	.8482
370	.8839	405	.8717	440	.8597	475	.8479
371	.8835	406	.8714	441	.8594	476	.8476
372	.8832	407	.8710	442	.8590	477	.8472
373	.8828	408	.8707	443	.8587	478	.8469
374	.8825	409	.8703	444	.8584	479	.8466
375	.8821	410	.8700	445	.8580	480	.8462
376	.8818	411	.8696	446	.8577	481	.8459
377	.8814	412	.8693	447	.8573	482	.8456
378	.8811	413	.8689	448	.8570	483	.8452
379	.8807	414	.8686	449	.8567	484	.8449
380	.8804	415	.8683	450	.8563	485	.8446
381	.8800	416	.8679	451	.8560	486	.8442
382	.8797	417	.8676	452	.8557	487	.8439
383	.8793	418	.8672	453	.8553	488	.8436
384	.8790	419	.8669	454	.8550	489	.8432
385	.8786	420	.8665	455	.8546	490	.8429
386	.8783	421	.8662	456	.8543	491	.8426
387	.8779	422	.8659	457	.8540	492	.8422
388	.8776	423	.8655	458	.8536	493	.8419
389	.8772	424	.8652	459	.8533	494	.8416
390	.8769	425	.8648	460	.8530	495	.8413
391	.8766	426	.8645	461	.8526	496	.8409
392	.8762	427	.8641	462	.8523	497	.8406
393	.8759	428	.8638	463	.8519	498	.8403
394	.8755	429	.8635	464	.8516	499	.8399

Group 2 (35.0 to 50.9° API)

t	M	t	M	t	M	t	M
0	1.0297	40	1.0099	75	0.9925	110	0.9752
1	1.0292	41	1.0094	76	.9920	111	.9747
2	1.0287	42	1.0089	77	.9915	112	.9742
3	1.0283	43	1.0084	78	.9911	113	.9737
4	1.0278	44	1.0079	79	.9906	114	.9732
5	1.0273	45	1.0074	80	.9901	115	.9727
6	1.0268	46	1.0069	81	.9896	116	.9722
7	1.0263	47	1.0064	82	.9891	117	.9717
8	1.0258	48	1.0059	83	.9886	118	.9712
9	1.0253	49	1.0054	84	.9881	119	.9707
10	1.0248	50	1.0049	85	.9876	120	.9702
11	1.0243	51	1.0044	86	.9871	121	.9697
12	1.0238	52	1.0039	87	.9866	122	.9692
13	1.0233	53	1.0035	88	.9861	123	.9687
14	1.0228	54	1.0030	89	.9856	124	.9682
15	1.0223	55	1.0025	90	.9851	125	.9677
16	1.0218	56	1.0020	91	.9846	126	.9672
17	1.0213	57	1.0015	92	.9841	127	.9667
18	1.0208	58	1.0010	93	.9836	128	.9662
19	1.0203	59	1.0005	94	.9831	129	.9657
20	1.0198	60	1.0000	95	.9826	130	.9652
21	1.0193	61	0.9995	96	.9821	131	.9647
22	1.0188	62	.9990	97	.9816	132	.9642
23	1.0184	63	.9985	98	.9812	133	.9637
24	1.0179	64	.9980	99	.9807	134	.9632
25	1.0174	65	.9975	100	.9802	135	.9627
26	1.0169	66	.9970	101	.9797	136	.9622
27	1.0164	67	.9965	102	.9792	137	.9617
28	1.0159	68	.9961	103	.9786	138	.9613
29	1.0154	69	.9956	104	.9781	139	.9608
30	1.0149	70	.9951	105	.9776	140	.9603
31	1.0144	71	.9946	106	.9771	141	.9598
32	1.0139	72	.9941	107	.9766	142	.9593
33	1.0134	73	.9935	108	.9762	143	.9588
34	1.0129	74	.9930	109	.9757	144	.9583
35	1.0124					145	.9578
36	1.0119					146	.9573
37	1.0114					147	.9568
38	1.0109					148	.9563
39	1.0104					149	.9558

Group 3 (51.0 to 63.9° API)

t	M	t	M	t	M	t	M
0	1.0361	35	1.0151	65	0.9970	95	0.9788
1	1.0355	36	1.0145	66	.9964	96	.9782
2	1.0349	37	1.0139	67	.9957	97	.9776
3	1.0343	38	1.0133	68	.9951	98	.9769
4	1.0337	39	1.0127	69	.9945	99	.9763
5	1.0331	40	1.0121	70	.9939	100	.9757
6	1.0325	41	1.0115	71	.9933	101	.9751
7	1.0319	42	1.0109	72	.9927	102	.9745
8	1.0313	43	1.0103	73	.9921	103	.9738
9	1.0307	44	1.0097	74	.9915	104	.9732
10	1.0301	45	1.0091	75	.9909	105	.9726
11	1.0295	46	1.0085	76	.9903	106	.9720
12	1.0289	47	1.0079	77	.9897	107	.9714
13	1.0283	48	1.0072	78	.9891	108	.9708
14	1.0277	49	1.0066	79	.9885	109	.9702
15	1.0271	50	1.0060	80	.9879	110	.9696
16	1.0265	51	1.0054	81	.9873	111	.9690
17	1.0259	52	1.0048	82	.9867	112	.9684
18	1.0253	53	1.0042	83	.9860	113	.9676
19	1.0247	54	1.0036	84	.9854	114	.9672
20	1.0241	55	1.0030	85	.9848	115	.9666
21	1.0235	56	1.0024	86	.9842	116	.9660
22	1.0229	57	1.0018	87	.9836	117	.9654
23	1.0223	58	1.0012	88	.9830	118	.9647
24	1.0217	59	1.0006	89	.9824	119	.9641
25	1.0211	60	1.0000	90	.9818	120	.9635
26	1.0205	61	0.9994	91	.9812	121	.9629
27	1.0199	62	.9988	92	.9806	122	.9623
28	1.0193	63	.9982	93	.9800	123	.9617
29	1.0187	64	.9976	94	.9794	124	.9611
30	1.0181						
31	1.0175						
32	1.0169						
33	1.0163						
34	1.0157						

Group 4 (64.0 to 78.9° API)

t	M	t	M	t	M	t	M
0	1.0419	35	1.0176	65	0.9965	95	0.9752
1	1.0412	36	1.0169	66	.9958	96	.9745
2	1.0405	37	1.0162	67	.9951	97	.9738
3	1.0398	38	1.0155	68	.9943	98	.9731
4	1.0391	39	1.0148	69	.9936	99	.9723
5	1.0384	40	1.0141	70	.9929	100	.9716
6	1.0377	41	1.0134	71	.9922	101	.9709
7	1.0370	42	1.0127	72	.9915	102	.9702
8	1.0364	43	1.0120	73	.9908	103	.9695
9	1.0357	44	1.0113	74	.9901	104	.9688
10	1.0350	45	1.0106	75	.9894	105	.9681
11	1.0343	46	1.0099	76	.9887	106	.9673
12	1.0336	47	1.0092	77	.9880	107	.9666
13	1.0329	48	1.0084	78	.9872	108	.9659
14	1.0322	49	1.0077	79	.9865	109	.9652
15	1.0315	50	1.0070	80	.9858	110	.9645
16	1.0308	51	1.0063	81	.9851	111	.9638
17	1.0301	52	1.0056	82	.9844	112	.9631
18	1.0294	53	1.0049	83	.9837	113	.9624
19	1.0287	54	1.0042	84	.9830	114	.9617
20	1.0280	55	1.0035	85	.9823	115	.9609
21	1.0273	56	1.0028	86	.9816	116	.9602
22	1.0266	57	1.0021	87	.9809	117	.9595
23	1.0260	58	1.0014	88	.9802	118	.9588
24	1.0253	59	1.0007	89	.9795	119	.9581
25	1.0246	60	1.0000	90	.9788	120	.9574
26	1.0239	61	0.9993	91	.9780	121	.9567
27	1.0232	62	.9986	92	.9773	122	.9560
28	1.0225	63	.9979	93	.9766	123	.9552
29	1.0218	64	.9972	94	.9759	124	.9545
30	1.0211						
31	1.0204						
32	1.0197						
33	1.0190						
34	1.0183						

Group 7 (94.0 to 99.9°API)

t	M	t	M	t	M	t	M
0	1.0531	25	1.0312	50	1.0090	75	0.9865
1	1.0522	26	1.0303	51	1.0081	76	.9856
2	1.0513	27	1.0294	52	1.0072	77	.9847
3	1.0505	28	1.0286	53	1.0063	78	.9838
4	1.0496	29	1.0277	54	1.0054	79	.9829
5	1.0487	30	1.0268	55	1.0045	80	.9820
6	1.0478	31	1.0259	56	1.0036	81	.9811
7	1.0470	32	1.0250	57	1.0027	82	.9802
8	1.0461	33	1.0242	58	1.0018	83	.9792
9	1.0453	34	1.0233	59	1.0009	84	.9783
10	1.0444	35	1.0224	60	1.0000	85	.9774
11	1.0435	36	1.0215	61	0.9991	86	.9765
12	1.0426	37	1.0206	62	.9982	87	.9756
13	1.0418	38	1.0197	63	.9973	88	.9747
14	1.0409	39	1.0188	64	.9964	89	.9738
15	1.0400	40	1.0179	65	.9955	90	.9729
16	1.0391	41	1.0170	66	.9946	91	.9719
17	1.0382	42	1.0161	67	.9937	92	.9710
18	1.0374	43	1.0152	68	.9928	93	.9701
19	1.0365	44	1.0143	69	.9919	94	.9692
20	1.0356	45	1.0134	70	.9910	95	.9683
21	1.0347	46	1.0125	71	.9901	96	.9674
22	1.0338	47	1.0116	72	.9892	97	.9665
23	1.0330	48	1.0108	73	.9883	98	.9656
24	1.0321	49	1.0099	74	.9874	99	.9647

EXAMPLE: Values in the table are in the form of multipliers; that is, the volume of oil at the indicated temperature and degrees API for each group, multiplied by the corresponding factor in the table, equals the volume at 60°F. For example, if the degrees API of an oil at 60°F equals 58 (group 3) and the volume at 88°F equals 8,000 gal., then the volume at 60°F equals 8,000 x 0.9830 or 7,864 gal.

CAPACITIES OF PIPES AND CYLINDERS

Inside Diameter	Gallons Per Foot	Barrels Per 100 Feet	Barrels Per Mile
1"	.0408	.0971	5.13
2"	.1632	.3886	20.52
3"	.3672	.8743	46.16
4"	.6528	1.5543	82.07
5"	1.02	2.4286	128.23
6"	1.4688	3.4971	184.65
7"	1.9992	4.76	251.33
8"	2.6112	6.2171	328.27
9"	3.3048	7.8686	415.46
10"	4.08	9.7143	512.91
12"	5.8752	13.9886	738.60
14"	7.9968	19.04	1005.31
16"	10.4448	24.8686	1313.06
18"	13.2192	31.4743	1661.84
20"	16.32	38.8571	2051.66
22"	19.7472	47.0171	2482.51
2' 0"	23.5008	55.9543	2954.39
3' 0"	52.8768	125.8971	6647.37
4' 0"	94.0032	223.8171	11817.55
5' 0"	146.88	349.7142	18464.91

(A convenient method of computing pipeline capacities is:

Inside diameter in inches, squared; multiplied by 5.13 equals 42-gallon barrels per mile.)

CONVERSION FACTORS

To Convert:	Multiply By:
B.T.U.'s per lb. to Calories per gram	0.5556
Calories per gram to B.T.U.'s per lb.	1.8
Centimeters to inches	0.3937
Circumference to Diameter	0.31813
Cubic Centimeters to Cubic Inches	0.061023
Cubic Feet to Cubic Meters	0.028315
Cubic Inches to Cubic Centimeters	16.387
Cubic Inches to Liters	0.016387
Cubic Inches to U.S.Gallons	0.004329
Cubic Meters to Cubic Feet	35.31445
Cubic Meters to U.S.Gallons	264.17
Cubic Feet to U.S.Gallons	7.4805
Diameter to Circumference	3.1416
Feet to Meters	0.3048006
Grains to Grams	0.06479895
Grams to Grains	15.432349
Grams to Ounces Avoir	0.0352739
Grams to Pounds	0.0022046
Imperial Gallons to U.S.Gallons	1.20094
Inches to Centimeters	2.54
Kilograms to Pounds Avoir	2.20462
Kilograms to Tons	0.0009842
Liters to Cubic Inches	61.023
Liters to U.S.Gallons	0.264178
Metric Tons to Pounds Avoir	2204.6223
Metric Tons to Tons	.98421
Ounces to Grams	28.34957
Pounds to Grams	453.593
Pounds Avoir. to Kilograms	0.453592
Square Centimeters to Square Inches	0.155
Tons to Kilograms	1016.047
U.S.Gallons to Cubic Inches	231.0
Tons to Metric Tons	1.01605
U.S.Gallons to Imperial Gallons	0.83268
U.S.Gallons to Liters	3.78533

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To find the number of Cubic Feet per Long Ton of a liquid, divide 35.96 by Specific Gravity of the liquid. Result will be approximate, but sufficiently accurate for practical purposes.